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Shops and their Upkeep

The question of the suitability of shops for manufacturing purposes is one which has entered into the provisions of the new Factories Act. Heating, lighting and ventilation are at last receiving the consideration they deserve. Naturally, when foundry proprietors have under consideration the construction of new buildings, or extensions to existing ones, they will obviously take cognisance of these modern trends. In general the British foundry industry is not badly housed, but there are some appalling exceptions. In the light castings industry, there is a tradition that the shops should be low, and in the Falkirk area they are known to this day as moulding sheds. Some comparatively new works have retained this type of shop, but the wooden rafters have been replaced by a network of interlacing braces. These almost inevitably gather dust, and where such a shop is used for enamelling, trouble can arise, and has arisen, when a particularly high wind has disturbed the accumulation. We have been unable to make up our minds as to whether a high building or a low shed provokes the more drafts. It is worth noting that in several instances where a light castings foundry has provided itself with a mechanised plant for the continuous pouring of castings, it has been found necessary to raise the roof.

If the Home Office decides to enforce its powers to heat foundries according to the standards they deem necessary, then there may be a tendency to keep new shops on the low side so as to economise in the cost of these services. The heating of foundries is not an easy proposition, especially where casting is intermittent and takes place only in the afternoon, as the heat from the liquid metal soon makes the shop too hot.

The large jobbing shops in general have adequate natural ventilation, on account of their height. Local ventilation is desirable, but a general system is unnecessary with modern methods. There are, of course, days when large floor moulds are being dried by coke baskets, and conditions then become trying. A major problem is the brown staining of the roof lights, especially in steel foundries, and successful methods for its cheap and rapid removal are still awaited by the industry. Some shops have water laid on the roof for external cleaning, and others have permanent gangways provided for dealing with the side lights.

There is a tendency for the modern shops to be of much lighter construction than their forerunners. Probably the old idea was that a well-built shop would always be a valuable asset, for in case the nature of the business changed, it could be used for a different type of manufacture. Modern requirements, however, have discounted this theory, and each type of manufacture nowadays demands its own particular type of building. So much attention is given to-day to mechanical handling that quite often the benefit of a gravity feed is lost through lack of height. Then again there is the publicity value of buildings, and those firms whose products reach the man in the street attach the greatest importance to the æsthetic aspect of their shops. One of the last works we visited was the Société l'Aluminium Français, and here between the various shops and offices is a well laid-out park. Cockerill, of Seraing, is another example, whilst the London suburbs can boast of many examples. Even a three-foot edge of garden surrounding a shop makes for efficiency, by preventing the exterior walls being used as temporary leaning places for discarded plant.

One factor which helps to foul shop conditions is the haphazard drying of ladles and shanks. A material improvement is noted both in shop conditions and in the cleanliness of the castings when this work is carried out under "common-sense" conditions.

Although some experts contradict us, we still believe that where regularity of production allows, the provision of an exhaust hood over the mould cooling conveyor in a mechanised shop is worth while. Where such equipment has been installed, it is noticeable that the atmosphere is much clearer around the mechanised bay than in the rest of the foundry.

The problem of the knock-out is receiving the considered attention of most of the equipment engineers. It is stated that where too much draft exists at this point, there is a serious loss of coal dust, but if a bag apparatus be installed for the final collection of dust, surely this could be returned to the system, even though it be contaminated with a certain amount of silt.

Looking at foundry buildings in general, it appears to us that the light castings industry should build new shops distinctly higher; that with the possible exception of a very few mass-production shops, natural ventilation can be adequate, when supplemented by auxiliary ventilation at well-defined places; that by the application of modern methods of heating much smoke and dirt can be eliminated; that provision should be made initially for easy working of the maintenance services; that the publicity value of the buildings should not be lost sight of, and finally that the yards should be made to look more like gardens and less like rubbish dumps.

Correspondence

[*We accept no responsibility for the statements made or the opinions expressed by our correspondents.*]

Some Factors in Sand Testing

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—With reference to Mr. Walker's letter in the July 7 issue of the FOUNDRY TRADE JOURNAL, there are some points I would like to amplify lest they be misunderstood. The modified metal box or mould for making B.C.I.R.A. test-pieces introduced by me was first the lengthened split form, of cast iron, and later the tube form, so that the permeability and green strength could be done on the same test-piece.

These tubes are best made with a highly finished bore, of hardened steel, and the pistons case-hardened and ground. The pistons should be 6 in. and 1 in. in length respectively. The tube will then be long enough to allow all the sand necessary for even the maximum degree of ramming to fall freely into the tube with preliminary ramming or levelling. Any preliminary ramming affects the ultimate distribution of ramming in the test-piece.

The mould B illustrated in Mr. Walker's letter seems to be getting away from this original idea and the principle on which it is based.

The use of the mallet for compressing the test-piece has also evidently become common, but this was never intended. The pressure required to make a test-piece is 80 to 100 lbs. each end (found by direct experiment), and there is a decided difference between applying this force as a steady squeeze and as a series of impacts. This point was proved in my last Paper given at a joint meeting in Birmingham.

These points were emphasised in the original suggestions, and also such details as sieving the sample of sand into a mixing drum. Only by observing strictly such details of method can sand testing be made easy and most fruitful.

The formation of the new committee which followed immediately after the above Paper is to be welcomed, and I agree with Mr. Walker that it is not before its time.—Yours, etc.,

WM. Y. BUCHANAN
(John Lang & Sons).

Johnstone, near Glasgow.
July 11, 1938.

"F.C.I.R.A."

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—The leading article of your issue of June 16 has been brought to my notice. I must confess that I am rather concerned at this—not least by the ironical remarks about me in the early part. I presume, and I do hope, that this arises only as a result of a misunderstanding and of an error of translation of my lecture to the Sté. des Ingénieurs Civils de France.

I am enclosing herewith the official text of this lecture (pages 146 to 150). No error can have arisen from a misunderstanding during its delivery, the text having been read in its entirety.

I first wish to dispose of the legend of the budget du Centre de Recherches de Fonderie. You say that the "free services" of this organisation "cost several tens of millions of francs each year." This is not at all what I said; you will see (page 149) that these "several tens of millions of francs" represent the economies realised in the budgets of the French foundries, due to the avoidance of waste, thanks to the advice given and to the activities of the Centre de Recherches; but this money is not collected by the Centre de Recherches, whose assistance is free; I even can say, by the way, that the budget of this Centre is much below that of the British Cast Iron Research Association!

But this is not the most important matter, which concerns the beginning of your article in which you attribute to me the naming of 1930 as the date of "the discovery of the two fundamental factors in the metallurgy of cast iron." The reading and the exact translation of my text (page 147) will show you that, if I mentioned these two titles of a communication made in 1930, it was not to fix that time for the discovery of these two factors; on the contrary, I wondered (not without humour) that such titles should not rather have appeared in the 18th century under the signature of Reaumur! I expressed my amazement at having heard such a thing in 1930!

Your ironical remarks about me correspond exactly to my own when mentioning that text!

Besides, the author of this Paper (1930) did not mean that the discovery was made at that time; far from it! He rather deplored the delay of the cast-iron founders as compared with the steel founders, and recalled these obvious truths; "la bonne parole" as we say in France, must, unhappily, be often repeated before being heard. . . .

I feel certain that you will understand my point of view. I strongly desire not to suffer from such an error and to be rehabilitated with those—very numerous—I have not the honour and the pleasure of knowing; for the others, I feel sufficiently sure of the cordiality of our connections to be persuaded that they have already made the rectification themselves.—Yours, etc.,

J. COURNOT.

2, Rue Joseph-Bara (6 Arr'),
Paris.
July 12, 1938.

[We wish to offer our profound apologies to Mr. Cournot. It is obvious that we failed to realise the irony in his remarks. Our object was solely to give credit to the results obtained by the earlier research workers.—EDITOR.]

Remelting Borings

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—We are faced with the problem of making provision for melting cast-iron borings and millings recovered from very light castings. On an average we have to dispose of 60 tons per week. Could any reader who has had a similar proposition to face advise us of the most suitable type of furnace for melting borings, or is there on the market a furnace where the flame is drawn or blown over the top of the charge, similar to the action of the air of a reverberatory furnace? The installation would be required to do 10 to 12 tons daily.—Yours, etc.,

"BORINGS."

[We have recently published a translation of an article on this subject by Signor Palmucci, together with a leading article on the subject, and have described the operation of an oil-fired rotary furnace which operates largely on turnings. We have also dealt with the "canning" and briquetting of borings.—EDITOR.]

(*Concluded from next column.*)

names to form a committee, whose function is to formulate a programme for the study of the economics and practice of converting solar energies into useful forms. The members of this committee include Professors Swett and Hottel taking the first prize, with Professors Hardy and Huntress following up as close seconds. With such names they should be able to hunt and sweat out the last drop of energy from that hot-as-'eil-and hardy customer the sun.

* * *

A contemporary daily reports that a foundry has been opened at the premises of the Blank Company, which "will be used for casting." This entirely kills the popular belief that foundries are used for making hot-cross buns.

"MARKSMAN."

Random Shots

The people of this island are nothing if not thorough, and having fought for and achieved an ambition they are determined to get the best out of it. Thus, "holidays with pay" does not merely mean that father gets a week at the seaside with an easy conscience and looser purse strings, but it seems to have become the pivot upon which the whole structure of domestic life is turning and inevitably changing in the process. Even our august Board of Education has graciously consented to wink an eye if the children take a week off to go to the seaside with their parents. That in itself is a tremendous concession, but is nothing to what they propose to do when the shifting school holiday scheme is properly developed. Even that is not the whole problem, for once the summer holiday is spread over, the important school examinations must necessarily be changed from the summer term to the winter term.

* * *

Then the railway companies have wakened up from a deep sleep to the sounding of an alarm bell which rings out "Holidays with Pay." School holidays altered, their efforts will no longer be confined to one month in which they annually attempt the impossible. Good services will have to be run to holiday centres from April to October and excursion tickets and other cheap travel facilities will perhaps have to operate during the middle of the week instead of the old-time custom of from Saturday to Saturday. In France they are not so lucky, or maybe it is only that public services do not react so swiftly to changed industrial conditions, for as yet the "40-hour week" plan has not managed to uproot the whole system of family and social life. Perhaps if the women had the vote things might move quicker, for it is essentially a domestic problem. The men are around the place so much, many wives grumble, and so long as the children go to school on Saturday how can the family get away for an odd week-end?

* * *

Incidentally, though our neighbours across the Channel might make more use of their newly-found leisure by taking a leaf out of the Englishman's book, whilst they continue to live in a country which produces such an abundance of good things to eat and drink, such good rivers in which to fish, and glorious countryside over which to follow *la chasse* or hunt the modest mushroom and wild strawberry, they have little to worry about. Walking in France a few days ago, "Marksman" lunched on many occasions in tiny inns along with lorry drivers and men working on tunnels, roads and bridges. "Marksman" particularly remembers one meal when he lunched in the company of three lorry drivers. They ate a variety of sliced sausage to begin with. Then followed a Russian salad, fit for the Savoy. After this came asparagus with mayonnaise, new fried potatoes, trout cooked in butter and finally fresh peaches and apricots. This was washed down with four *picholets* of the red wine of the district, and rounded off with coffee and rum. Later, the daughter of the house apologised to her unaccustomed guests for the very humble meal!

* * *

Everybody has frequently been struck by names which are peculiarly appropriate (or just the reverse) to the main interests of the proud bearers of those names. The name of Sir Guy Dawber springs to mind in this connection—what a name for an artist of such eminence! Once, in a provincial city in the North, there were two doctors, partners, who rejoiced in the names of Kilham and Dearden. Their patients could scarcely resist the temptation of making out their cheques (especially if unduly long) to Dr. Kill'em and Dr. Dead'un (pronounced in true northern fashion). America has now managed to find a particularly apt bunch of

(*Concluded in previous column.*)

The Founding of Nickel-Bronze and Allied Alloys

By FRANK HUDSON

Nickel additions are made to bronze and allied alloys in amounts varying from 0.5 to over 50 per cent., and the methods to be adopted in the practical founding of these alloys depend to a large degree upon the quantity of nickel present. Accordingly, it is proposed to consider the subject under three group headings:—(I) Small additions of nickel up to 5 per cent.; (II) additions of nickel between 5 and 10 per cent.; and (III) additions of nickel over 10 per cent.

I.—ADDITIONS OF NICKEL UP TO 5 PER CENT.

Within this range no special precautions need be taken apart from those coincident with the production of high-quality non-ferrous castings. Small additions of nickel improve the mechanical properties, promote solidity, homogeneity, grain refinement, and give a wider latitude in pouring temperature, thus tending to assist and simplify foundry operations. The following points should, however, be kept in mind.

Composition of Charge

Pure nickel pellets or 50/50 nickel-copper alloy shot are recommended for making the required addition, and these should be placed in the bottom of the crucible or furnace along with the bulk of the metal when charging commences. *Nickel F shot should not be used* for this purpose, as this contains appreciable quantities of silicon, which is detrimental to the alloys in this group. In keeping with accepted practice, remelted metal such as ingots or approved scrap is to be preferred to the use of virgin metals for the basis of the charge, if the highest quality is desired in the castings. This is of particular importance in the so-called zinc-free alloys such as phosphor, gear or acid-resisting bronze. The presence of a small amount of zinc is a great asset in the production of non-ferrous castings, and past experience in both engineering and the foundry indicates that, up to 0.5 per cent., zinc has no noticeable detrimental effect on either wearing properties or resistance to corrosion. It has been suggested in the past that zinc has a deleterious effect on bearing or gear bronzes, due to the fact that it hardens the alpha phase and thus lessens the differential hardness between this and the alpha-delta eutectoid. In practice, however, this has never been substantiated, and it is considered that up to 1.0 per cent. zinc is not likely to affect properties in service. Similarly, in the production of the zinc-free acid-resisting bronzes, soundness in the casting is equally important as composition for adequately resisting corrosion, and in view of the beneficial effects of small zinc percentages in this direction, it is definitely preferable to include 0.5 per cent. in the composition. Zinc can be conveniently added in the form of Muntz metal scrap along with the nickel and copper.

Melting

The best results are obtained by melting as rapidly as possible in a slightly oxidising atmosphere. Modern forced-draft coke or oil fired crucible furnaces will melt an 80-lb. charge of bronze or gunmetal in 30 min., increasing to approximately 1½ hrs. for 400 lbs. of metal, and these times should be kept in mind as a guide to the best practice in this direction. Furthermore, under such conditions, little difficulty is experienced in obtaining the right kind of furnace atmosphere containing from 0.2 to 0.8 per cent. free oxygen. A greater oxygen content than this will cause excessive melting losses and oxidised metal, whilst its complete absence is liable to promote gas absorption and lack of solidity in the final casting. It is a wise precaution to have the exhaust gases analysed, particularly if the furnace has a flue connected to a stack or chimney, in order to get some idea of the amount of free oxygen present at any particular setting of the oil or blast valves. In open-top furnaces not connected to a flue the presence of free oxygen can be easily observed by the colour of the exhaust flame, which should be transparent yellow with green edge bordering to yellowish-green. The depth of the greenish tints is roughly proportional to the amount of free oxygen present.

In the case of natural-draft coke-fired furnaces the above ideal conditions are not so readily obtained. Melting is slower and usually a

TABLE I.—*Furnace Control Chart for Bronzes and Allied Alloys containing up to 5 per cent. Nickel.*

Type of furnace.	Method of firing.	Fuel specification.	Advantages.	Disadvantages.	Suggested practice to obtain highest metal quality.		
					Furnace operation.	Cover on metal.	Deoxidiser.
Crucible	Coke. Natural draft	Gas works or furnace coke according to draft available. Size 1¼ to 2¼ in. Ash not over 10 per cent. Sulphur under 1 per cent.	None	Melts slowly with reducing atmosphere unless fitted with high stack or chimney drawing on a limited number of fires	Increase melting rate. A. Use smaller crucible* (preferably super grade). B. Increase coke space. C. Increase draft. D. Use ingots and scrap. Do not use wet coke.	Use oxidising slag such as manganese ore (or similar) and keep it active.† Cover pot to prevent entry of coke	None usually required for alloys containing zinc. Use 1½ to 2 ozs. 15 per cent. phosphor-copper per 100 lbs. metal if necessary.
Crucible	Coke. Forced draft	Hard furnace coke. Size 1¼ to 2¼ in. Ash not over 10 per cent. Sulphur under 1 per cent.	Melts rapidly with slightly oxidising atmosphere	None	Set air slide to give 0.2 to 0.8 per cent. free oxygen in exhaust gases. Use dry coke	Not essential but use of oxidising slag often beneficial	As above.
Crucible	Oil	Light to medium grade. Sulphur not over 0.5 to 1.0 per cent.	Melts rapidly. Wide range of furnace atmospheres	Requires closer supervision than above	Set air and oil valves to give 0.2 to 0.8 per cent. free oxygen in exhaust gases	As above	Deoxidise with phosphor-copper in all cases.
Reverberatory ..	Oil	Light to heavy grade according to type of burner employed. Sulphur not over 0.5 to 1.0 per cent.	As above ..	Requires very close supervision and careful control, otherwise tendency for excessive oxidation and high melting losses	Set air and oil valves to give 0.2 per cent. max. free oxygen in exhaust gases	Very mild oxidising cover advisable. Control dilution by addition of glass	As above.
Electric	Rocking arc ..	—	Melts rapidly ..	Slightly oxidising atmosphere difficult to obtain with some furnace designs	Fit controlled auxiliary air supply or adapt furnace so that slightly oxidising conditions are obtained	Mild oxidising slag can be used if necessary	None usually required for alloys containing zinc. Use phosphor-copper if necessary.
Electric	Induction. High frequency.	—	Melts rapidly ..	High cost. Excessive oxygen content in furnace atmosphere	Reduce oxygen content in furnace atmosphere by suitable cover on metal	Mildly oxidising slags can be employed if furnace is designed for refining. Otherwise use charcoal, blacking or coal dust to reduce oxidising conditions	Deoxidise with phosphor-copper in all cases.

* "Super" plumbago crucibles have higher heat conductivity than ordinary grades.

† Covering slag can be kept active by adding half quantity at beginning and remainder in middle of heat. (Normally 0.75 to 1.5 per cent. of charge weight is required when using manganese ore.)

neutral or reducing atmosphere predominates. Improved results can, however, be obtained under such conditions by the use of a covering slag or flux which evolves a small amount of oxygen on heating. Materials such as manganese-dioxide (in the form of manganese ore),* black copper oxide, etc., are suitable for this service.

It is becoming increasingly recognised that in the production of sound non-ferrous castings careful control of the melting operation is of importance, particularly so far as the reactions between metal/slag covering/furnace atmosphere are concerned, and Table I outlines recommended practices to meet melting variables likely to be encountered in different foundries. The use of a suitable slag cover controls the supply of oxygen to the metal, acting like a balancing valve between metal and furnace atmosphere. For example, in natural-draft coke-fired units where a reducing atmosphere usually predominates, the oxidising slag steadily feeds a small amount of oxygen to the metal as long as it contains oxygen. It cannot, however, replenish its oxygen content from the furnace atmosphere, and accordingly effective action depends essentially upon melting time. If this is prolonged, steps must be taken to revivify by further flux additions. In practice this is only likely to arise under reducing conditions and when melting times exceed 1½ hours, and can be overcome by adding half the flux at the beginning and the remainder midway through the heat, thus extending the action up to 3 hours.

In all cases it is also advisable to use dry coke for melting, as the water vapour so produced has a deleterious effect on metal quality, particularly when such conditions are associated with reducing atmospheres.

In the extreme case of furnaces operating with a highly oxidising atmosphere, conditions are simplified as the cover can replenish its oxygen content from the atmosphere and so remain effective. More important still, it prevents excess oxygen reaching the metal, as it can only still supply what it initially evolves. Under ideal furnace conditions where a slightly oxidising atmosphere can be readily maintained, the use of a cover for melting alloys in this group can be omitted.

In the case of crucible furnaces, after the metal is thoroughly melted and adequately superheated, the slag covering can be thickened if necessary by the addition of parting sand or powdered lime (CaO) and removed by skimming from the side opposite to the pouring spout.

* 0.75 to 1.5 per cent. of the total metal charge crushed down to ¼-in. particles or less.

Deoxidation may or may not be required, depending upon melting conditions and the composition of the alloy, and for further information on this matter reference should be made to Table I. In those cases where deoxidation is advisable, phosphor-copper is recommended for this purpose, adding about 1½ to 2 ozs. of 15 per cent. phosphor-copper per 100 lbs. metal, after skimming and immediately before pouring. It is sufficient to throw the deoxidiser upon the surface of the metal and stir in.

Pouring

No difference in pouring practice is entailed by additions of nickel up to 5 per cent. to bronzes. As a matter of fact, greater latitude is possible in this direction, and higher temperatures can be employed without reduction in mechanical properties. An approximate indication of suitable pouring temperatures for a range of alloys appears later in this Paper.

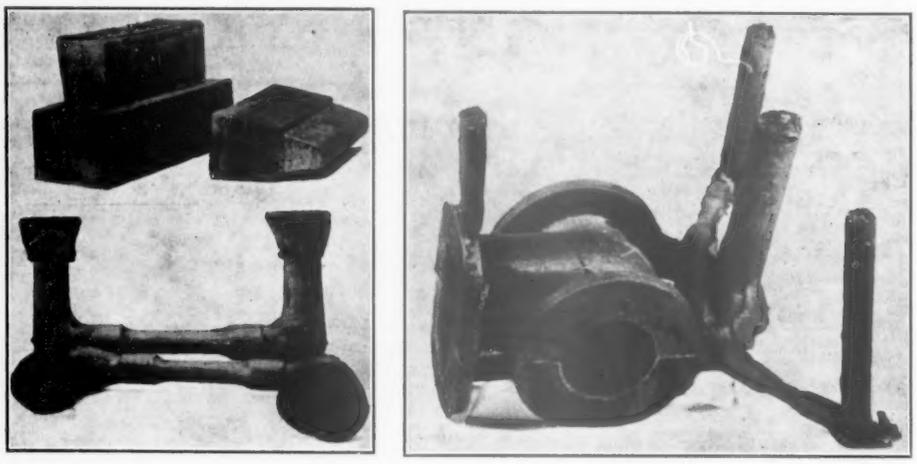
Moulding Methods

Here again no modification is required to existing practice, and normal moulding and gating methods are satisfactory, as will be observed from Fig. 1, which illustrates the usual way of founding such alloys. It is interesting to note the method of attaching "cast-on" test-bars to the valve body shown, whereby they are fed by the main ingate and individually supplied with well-proportioned risers. In far too many instances insufficient care is taken with the placing of test-bars, and the method outlined has proved most successful in practice. So far as bronze and gunmetal castings are concerned, a well-designed runner can be relied upon to give better feeding action than risers. At the same time it should be noted that small additions of nickel materially assist feeding action and are particularly valuable in promoting solidity. This property is of particular assistance when the design of casting is such as to prevent the placing of runner and risers in the most advantageous position.

When bronze and allied alloys have to be cast in contact with iron or steel, they must be thoroughly deoxidised, even when containing zinc, as blowholes or porosity are liable to occur due to a reaction between free oxygen in the bronze and carbon in the iron or steel. For use as chills or denseners cast-copper or high heat-conductivity moulding compositions are preferable, and nickel additions to bronze increase the effective depth of chill obtained by such means.

Contraction and machining allowances for bronze and allied alloys are not in any way affected by small nickel additions.

(To be continued.)



A B

FIG. 1.—METHODS OF MAKING CASTINGS IN BRONZES CONTAINING UP TO 5 PER CENT. NICKEL
A, SEPARATE CHILL-CAST AND SAND-CAST TEST-BARS. B, VALVE BODY WITH CAST-ON TEST-BARS.

The gating methods employed are normal to efficient brassfoundry practice. The method of attaching test-bars as shown in B can be particularly recommended.

Uncertain Copper Outlook

BY "ONLOOKER."

It is a curious fact that the American copper producers rarely seem capable of doing the right thing in regard to the price of their commodity. Recent events have shown that in this matter they still have much to learn. In the earlier months of this year, in face of consumption in the U.S.A. at the rate of about 20,000 tons per month, 10 cents was stoutly maintained on the domestic market, although it appeared to be obvious that users were not interested at that level.

If this were true of America it proved to be true also of the rest of the world eventually, for the time came when demand all round had fallen to a level at which it seemed evident that some stimulus was necessary. Taking the bull by the horns, the American producers lopped 1 cent off their quotation and thereby badly scared the market. This overnight reduction of more than £4 per ton appeared to consumers to indicate that only a desperate state of affairs could require such drastic corrective measures, and in consequence their response was anything but hearty.

Effect of Wall Street Activity

In the States second hands brought offers down to an 8½ cents level, but still buyers maintained an indifferent mien and producers grew alarmed. Drastic measures of curtailment were announced in America, and even the affiliated producers outside the States decided to reduce to 95 per cent. of the standard tonnages, the cut being therefore 10 per cent. Whether or not these measures would have had the desired effect is uncertain, but at the crucial moment Wall Street began to froth and bubble, and much to the surprise of the man in the street the volcano which most people had come to regard as extinct burst into activity.

The rapidity of the rise was really phenomenal, and after one check which was soon overcome the market went ahead. In fact, at the time of writing it is by no means certain that the upswing has finished, although the market looks distinctly tired. Commodities had begun to improve slightly before the boom on Wall Street started, but with stocks and shares soaring buyers of copper lost their sense of proportion and in a rush to cover their needs for months ahead they enabled a price advance to 9¾ cents.

Reactions in London

The London market went ahead, too, but much of the buying in Whittington Avenue was speculative. Consumers rather held off, taking the view that the upswing in America was by way of being a ramp and therefore not worth following. Some support was lent to this theory by the fact that a good deal of the tonnage purchased in the U.S.A. was reported to have been secured by dealers, who would, of course, resell it as soon as the time was ripe. Standard copper, which at the lowest point this year was down to £32, struggled up to £40 10s., but is now somewhat below this, following reports of price shading across the Atlantic.

What is to be the next move? It may be assumed that producers in the States are in a fairly comfortable position, having sold their output for a few months ahead, but it must be remembered that in the U.S.A. stocks are still heavy, and that the holding in second hands is considerable and is bound to depress values sooner or later. Nor is the time of year auspicious for a genuine uplift in business activity. All things considered, it looks as if the advance beyond 9 cents was a mistake in tactics which may even lead to a still lower price later in the year.

Chemical Changes in Cast Iron in the Cupola*

By JAMES T. MACKENZIE†

The cupola is a hollow shaft of refractory open at the top to admit solid fuel, metal and, incidentally, flux, with openings near the bottom to allow air to enter, and below these to let the slag and metal flow out. The usual steel shell is incidental to holding the refractory shell together, and the other metal appurtenances are mechanical contrivances for delivering the blast, holding slag and iron until ready for delivery, etc. Primarily, the purpose of the refractory is to hold heat and cause it to be absorbed by the iron. The flux is to render fusible the ash of the coke and such silicious material as is charged with the metal or is melted from the lining. Most of the principles of physics and chemistry are at work simultaneously during a heat, but it is often difficult, if not impossible, to determine at a given point, time or level, which ones are in control and which in abeyance.

Assuming that the lining is of a fairly satisfactory refractory, there are really five factors which control the effluent metal:—

(*a*) The metallic charge—its chemical composition and the ratio of its surface to weight or, generally, the size of the pieces.

(*b*) The fuel—its composition, size, shape and structure, and its weight in proportion to the iron.

(*c*) The blast—its temperature, moisture content and velocity (local as well as mean).

(*d*) The structural details of the cupola.

(*e*) The amount and quality of the flux.

The changes in the iron are mainly due to the oxygen of the blast and its reaction with the coke, the carbon and sulphur of the coke, and the fluxing power of the flux. Other changes are due to temperature-solubility relationships, but practically no change is a linear function of any one condition, reaction or property. Table I shows a list of the variables to be found in ordinary practice, and even this may not be complete, not only for the obvious reason that the author has overlooked some, but that there may be some not yet recognised by anyone. Fortunately, however, many of these can be held constant for all practical purposes, so that others can be studied, if not exactly singly, at least in small groups. It should be remembered that such studies should be reported only in the past tense as a warning that the exact conditions of the experiment might never occur again.

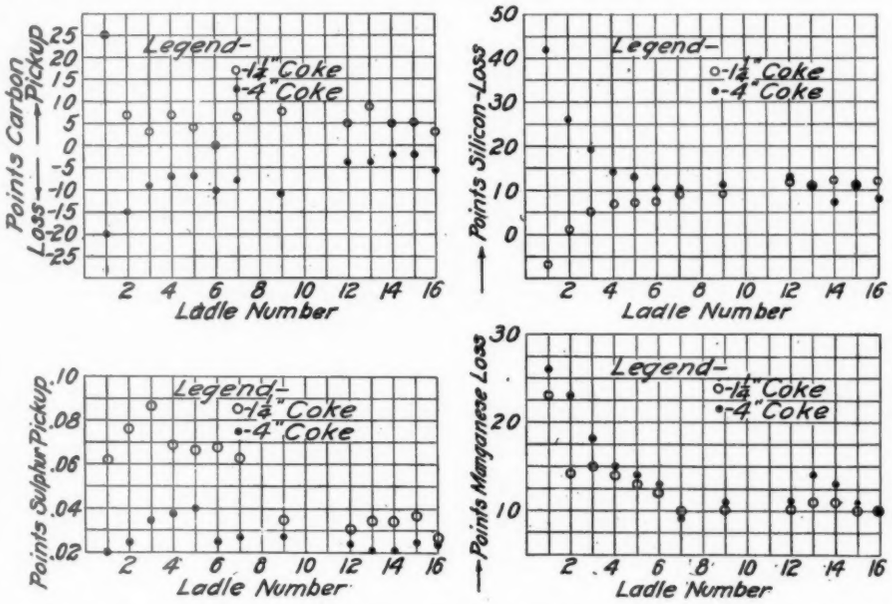


FIG. 1.—VARIATIONS IN DIFFERENT ELEMENTS IN HEATS OF LONG DURATION WHEN USING VARIOUS-SIZED COKES.

This Paper does not attempt to cover the work that has been done along these lines by other investigators, but is frankly a review of the work done by the author and his collaborators at the American Cast Iron Pipe Company in Birmingham, Alabama, and reported to the Institute of British Foundrymen,[1] and to the American Foundrymen's Association,[2 3 4] together with some tests not previously published.

The Three Zones

The most important changes in the iron (at least, so it seems to-day) are:—(1) The oxidation of iron, carbon, silicon and manganese, and (2) the absorption of carbon and sulphur. There are three laboratories in the cupola fairly easily defined on paper, but which are not so easily separated in the furnaces, it is thought, as foundrymen are prone to think. These are: the *shaft*, where the metal is still solid; the *melting zone*, where the oxygen of the blast is used up, where the ash of the coke is being released to form slag, and the iron is trickling through the burning coke; and the *hearth*, where the liquid iron and slag collect in the interstices of a mass of coke to separate before withdrawal.

Of the reactions in the shaft the most important is apparently the absorption of sulphur and some oxidation. In the Paper on size of coke[4] the initial absorption of sulphur on the small coke is very high, as compared to the large coke (Fig. 1), as long as the original filling of the cupola was being melted (through the 7th tap), and this was the only variable so affected. The bed height being the same in both cases, a great deal more small coke was burned before melting began than large, with consequent exposure of the solid iron in the shaft to the sulphur. High beds are notoriously prone to high sulphur on the first charges. Table II gives some hitherto unpublished tests on height of bed, which show that while the sulphur pick-up on the 3rd and 5th ladles changed from 0.044 to 0.076 per cent., on the first ladle it rose from 0.044 to 0.119 per cent. as the bed was raised from 30 to 50 in. (tests on the 21-in. cupola used in (3)).

Reactions in the Stack

Oxidation is probably a minor reaction in the stack. With about 10 per cent. coke ratio (normal cokes) Piwowarsky shows virtually constant CO_2 and CO ratio above the melting zone. Probably most of the oxidation of small scrap is from solid pieces falling through the coke down into the lower part of the melting zone, where there is free oxygen.

Carburisation in the stack is also exceedingly small. The Boudouard relations show nearly 80 per cent. CO necessary for reduction of oxide at 1,200 deg. C., and few cupolas run over 60 per cent., most, probably, running below 50 per cent. In running a test with a still steel residue,[1] the blast was on for over an hour with no melting. When the bottom was dropped a piece of wrought iron was found which had just begun to melt, and this was examined microscopically. About one hundredth of an inch around the circumference was found to be carburised to approximately 0.50 to 1.50 per cent. carbon. This must have been in a very high CO atmosphere rich with hydrocarbons for the full time, for the coke was about 18 per cent. volatile and the flames were a deep rich red, reaching a height of 20 ft. or more above the stack, as compared to a pale blue of about 5 ft. for a normal (ABC) coke with the particular bed, blast

TABLE I.—*Variables in Cupola Melting.*

(*a*) Metal.	(*b*) Coke.	(*c*) Blast.	(*d*) Construction and operating details.	(*e*) Flux.
Size	Size	Velocity	Size of cupola	Size
Shape	Shape	Temperature	Shape of lining	Shape
Carbon-free	Carbon	Moisture	Size, shape and distribution of tuyeres	CaO
Carbon as carbides	Ash, amount and composition	Sulphur	Depth of well	MgO
Silicon	Volatile	Oxygen	Height from tuyeres to charging door	Na_2O
Phosphorus	Sulphur		Height of bed	SiO_2
Manganese	Organic		Size and distribution of charges	CO_2
Sulphur	Sulphide		Method of slag and iron removal	Sulphates
Oxides	Sulphate		Ratio of iron to coke and flux	Sulphides
Nickel	Strength			Other oxides
Chromium	Cell space			
Molybdenum	Moisture			
Copper	Reactivity			
Titanium				
Vanadium				
Arsenic				
Possibly others usually insignificant				

* Paper presented on behalf of the American Foundrymen's Association to the Annual Conference of the Institute of British Foundrymen at Bradford.

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and coke ratio used. The fact that no iron melted showed that the reaction to CO was too rapid to raise the temperature to the melting point.

Hearth Reactions

The hearth is also comparatively simple. The Paper by Johnson[3] showed that whatever effect the depth of the hearth has on carburisation, it was obscured in so many cases that no rule could be postulated. Fig. 2 shows that in three out of five pairs of tests the low (4 in.) tuyeres gave higher carbons than the high (16 in.), but that in all three pairs of intermittent taps *versus* continuous flow, the intermittent tap gave higher carbons than continuous flow, this effect being far greater on the low tuyeres than the high. A personal thought is that the amount and fluidity of the slag interfere so with the iron-coke contact that depth of coke below the tuyeres is of secondary importance. Then, again, the coke at the level of, and just below, the tuyeres must be much hotter than that farther down. In continuous flow, the coke will in general be well covered with slag with only a shallow bath of iron, but in the periodical filling of the hearth during tapping the iron lifts the slag with it as it rises and thus has a chance to come in contact with clean coke.

TABLE II.—*Effect of Bed Height on Analysis Changes.*

Coke.—ABC. Size 3 in. by 1½ in.—10 per cent. of metal charge.
Flux.—Dolomite. 2 per cent. of metal charge.
Blast pressure.—4.4 ozs.

Bed height.	Sample.	Temp., deg. C.	C.	Si.	S.	Mn.	P.	Pick-up, per cent.		Loss, per cent.	
								C.	S.	Si.	Mn.
					0.052*						
	As charged		3.55	1.75	0.060	0.41	0.71				
30 in.	1st ladle	1,443	3.55	1.70	0.096*	0.29		0.00	0.044	0.05	0.12
	3rd and				0.096*						
	5th ladles	1,448	3.49	1.68	0.110	0.34	0.69	−0.06	0.044	0.07	0.07
					0.062*						
	As charged		3.40	1.48	0.072	0.47	0.65				
40 in.	1st ladle	1,398	3.57	1.44	0.104*	0.30		0.17	0.042	0.04	0.17
	3rd and				0.126*						
	5th ladles	1,498	3.43	1.40	0.136	0.40	0.64	0.03	0.064	0.08	0.07
					0.053*						
	As charged		3.48	1.48	0.063	0.49	0.68				
45 in.	1st ladle	1,482	3.65	1.55	0.106*	0.34		0.17	0.053	−0.07	0.09
	3rd and				0.112*						
	5th ladles	1,515	3.45	1.42	0.120	0.43	0.69	−0.03	0.057	0.06	0.06
					0.061*						
	As charged		3.52	1.55	0.070	0.38	0.69				
50 in.	1st ladle	1,387	3.46	1.69	0.180*	0.31		−0.06	0.119	−0.14	0.07
	3rd and				0.129*						
	5th ladles	1,515	3.50	1.50	0.146	0.35	0.65	−0.02	0.076	0.05	0.03

* Evolution, others estimated gravimetrically.

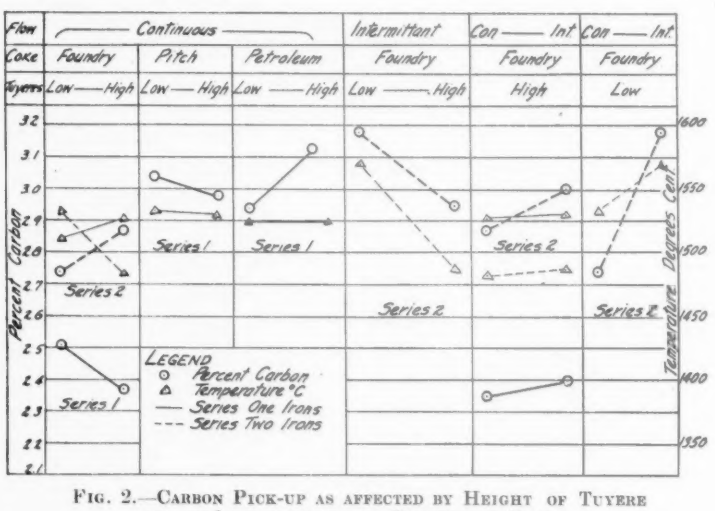

FIG. 2.—CARBON PICK-UP AS AFFECTED BY HEIGHT OF TUYERE AND BY INTERMITTENT AND CONTINUOUS FLOW.

Needless to say, all other open-hearth and puddling furnace reactions are possible, but are seldom encountered. A slag with high iron oxide will decarburise or oxidise the silicon and manganese, depending on the temperature, and a basic slag will doubtless desulphurise, but when these unusual slag conditions occur, the melting zone reactions are usually so affected that it is difficult to say that the relatively short time of contact of slag and iron in the well was responsible, especially considering the relative quietness and the presence of a volume percentage of about 65 per cent. of coke, which quite probably interferes with the usual oxidation reaction of the open hearth. Several cases of lowering sulphur by adding limestone, soda ash, and sometimes by increasing the volume with sand or gravel, have been reported (at least one case in large-scale production reported to the author personally by a competent metallurgist), but it seems that the explanation is more likely to be found in sulphur absorption in the stack by the increased basic oxides, or in improvement of the melting conditions by an increase in slag volume or fluidity, than in actual reaction in the hearth.

The melting zone is the laboratory where most of the necessary work is done and most of the reactions occur. Cupolas are operated with very little stack and almost no hearth. Here the oxygen of the blast combines with the carbon of the coke to form carbon dioxide, which acts on more carbon to form carbon monoxide—the first generating heat and the second absorbing it. It is a mistaken idea to think of these two reactions as occurring in steps. For that reason words instead of symbols have been used, for when the following reactions are written:—

R_1.....$O_2 + C = CO_2$
R_2.....$CO_2 + C = 2CO$

it always gives a personal impression that after reaction R_1 was all finished with, the meeting adjourned and convened next day, say in London, where reaction R_2 was carried out, whereas it is known that CO is being formed while there is still considerable free oxygen present and that some oxygen may form CO directly.

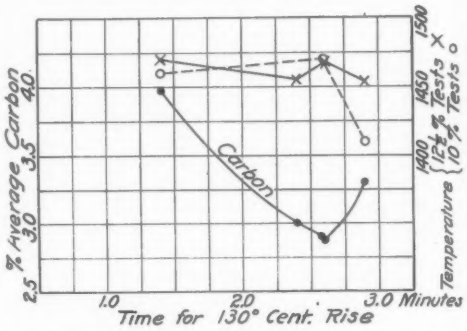

FIG. 3.—RELATION BETWEEN BURNING TIME OF COKE AND AVERAGE CARBON AND TEMPERATURE OF THE 8TH, 9TH AND 10TH MELTS. THE 12½ AND 10 PER CENT. TESTS REFER TO THE AMOUNTS OF COKE USED IN THE MELTS.

Minor reactions with the coke are the burning of sulphur to the dioxide or trioxide, the decomposition of the water of the air into hydrogen and eventually carbon dioxide and, in the cooler parts of the stack, a possible reversion of the carbon monoxide to carbon dioxide and carbon.

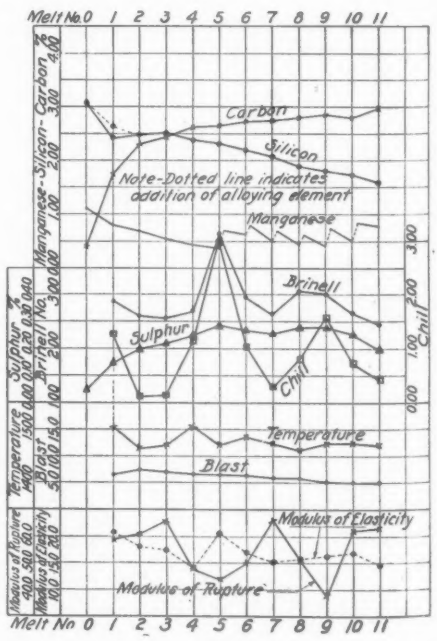

FIG. 4.—EFFECT OF REPEATED MELTING. (See Table V.)

The metals and metalloids of the charge react with the rust and other oxides in the charge, including coke ash, with the refractory lining, and with the oxygen from the blast.

The physical reaction due to heat alone is primarily that of melting, but in addition there is decomposition of the carbonate fluxes with

liberation of carbon dioxide in the stack, volatilisation of metallic manganese, and decomposition of the pyrites which are present in many limestones.

Reactions and Temperature

The rapidity of the reaction of the carbon of the coke with the oxygen of the blast is the governing factor in most cases. If the coke reacts sluggishly with CO_2 in the stack, a large amount reaches the melting zone to react, though perhaps sluggishly, with the oxygen, whereas a coke reacting rapidly in the stack gives less carbon in the melting zone. Conversely, a coke which burns rapidly at the tuyeres, thus giving a localised high temperature, reacts rapidly with the CO_2 formed to lower that temperature by forming CO. This is probably the reason why such unsatisfactory results have been obtained when correlating reactivities and melting temperatures. Fig. 3 is a good illustration[2] of this—a fact which has been noted by other investigators, most recently by Pearce.* It also explains why increasing coke affects the temperature so little, for as the amount of coke increases the CO percentage increases with considerably greater rapidity. In American practice the temperatures range from about 1,350 to 1,600 deg. C., with coke ratios varying from about 6 to 17 per cent. —a 16 per cent. increase in temperature for a 200 per cent. increase in coke, although the superheat (temperature above freezing) of the melt is about doubled:—

$$\frac{1600 - 1130}{1350 - 1130} = \frac{470}{220} = 214 \text{ per cent., or an increase of 114 per cent.}$$

The highest temperatures are obtained only by a combination of high blast velocities (volumes) with high coke ratios, which makes a deep zone of high temperature for the molten iron to fall through.

The factors that have been studied by the author, which have been suggested as most important, are:—

The properties and size of the coke.
The pressure (volume) of the blast.
The composition and size of the metallic charge.

The studies have been made largely on the basis of the changes in carbon, silicon, sulphur and manganese, and the temperature, chilling properties of a 1½-in. by 3-in. by 6-in. block, and strength and stiffness of 2-in. by 1-in. test-bars tested flatwise on 24-in. supports. Some effects which might be of importance in feeding and shrinkage problems, or the chilling of light sections, etc., would pass unnoticed in these tests.

The 1927 Paper[1] gave the results from a very wide range of cokes, the data on carbon and sulphur being shown in Table III. These were all-steel charges, except for silicon and manganese alloys, which averaged about 0.40 per cent. carbon and 0.040 per cent. silicon. This shows a variation in carbon absorbed of 2.54 per cent. (from 1.73 to 4.27 per cent.) and in sulphur of 0.093 per cent. (from 0.102 to 0.195 per cent.). Apparently, the ash is an important factor in the absorption of carbon, but other properties can outweigh it to a large extent. For example, Fire Creek gave low carbon with low ash, but it had an extremely high shatter test and high porosity. The Bradford was so weak (shatter 50) that much of it blew out of the stack in small pieces during the melt. There may be other reasons for these two out-of-line results, but these are at least suggested by the Table.

The 1930 Paper[2] gave a large number of results on the six cokes shown in Table IV. These tests were started on some 1,000 to 2,000 lb. heats and repeated until there was only about 500 lbs. left (the loss being melting loss, including spillage, and test specimens which had to be kept for future reference). Typical records are shown in Table V, Fig. 4, an all-steel charge; Table VI, Fig. 5, starting from a most unusual high-sulphur pig-iron; and Table VII, Fig. 6, a normal coke and normal pig-iron. This last is also of interest, in that oxygen and nitrogen were determined on the first and last heats. These tests showed clearly that, for any given coke, the carbon tended to reach a certain value, but that this value was strikingly different for the different cokes, as was shown in Fig. 3, which gives the average carbon of the 8th, 9th and 10th melts plotted against the results of the Boegehold test.

TABLE III.—*All-Steel Charges + 50 per cent. Fe-Si and 80 per cent. Fe-Mn.*

Coke.	Oven.	Ash.	Volatile.	S.	Porosity.	Shatter.	Sp. gr.	Carbon in melt.	Appearance of coke.
Dayton ..	Bee hive ..	17.0	0.4	1.7	59	70	1.94	1.73	Dull grey, overburned.
Sewanee ..	Bee hive ..	16.9	0.7	0.6	—	80	—	1.80	Silver bright.
Fire Creek ..	Bee hive ..	5.8	0.6	0.5	59	93	1.94	2.10	Dull, light grey.
Bradford ..	Bee hive ..	3.9	0.5	0.5	50	50	1.80	2.81	Silver bright.
A.B.C. ..	By product	10.0	0.7	0.6	46	68	1.92	2.50	Dull, dark grey.
A.B.C. ..	Unbroken	—	—	—	—	—	—	2.17	Dull, dark grey.
Barrett ..	Bee hive ..	1.1*	0.9	0.4	47	88	1.85	3.38	Dull black.
Bayonne ..	Unknown ..	0.1	5.0	1.2	—	75	—	3.54	Dull black.
Parco.. ..	Still residue	0.2	15.0	0.5	—	55	—	4.27	Shiny black.
Wichita Falls	Still residue	0.3	14.0	1.4	51	52	1.92	No melt	Dull black.
Shell	Still residue	1.4	18.0	1.4	—	—	—	No melt	Dull black, badly broken.

* Largely dust from long storage—the new coke runs about 0.4 per cent. ash. This extraneous excess would not affect the properties of the coke.
Carbons calculated to basis of 2.00 per cent. Si, 0.10 per cent. P, and 0.50 per cent. Mn.
Shatter is amount remaining on 2-in. screen after four drops from 6 ft.
Porosity (or cell space) determined according to A.S.T.M. standard method.
Charge about 0.4 per cent. carbon and 0.04 per cent. sulphur.

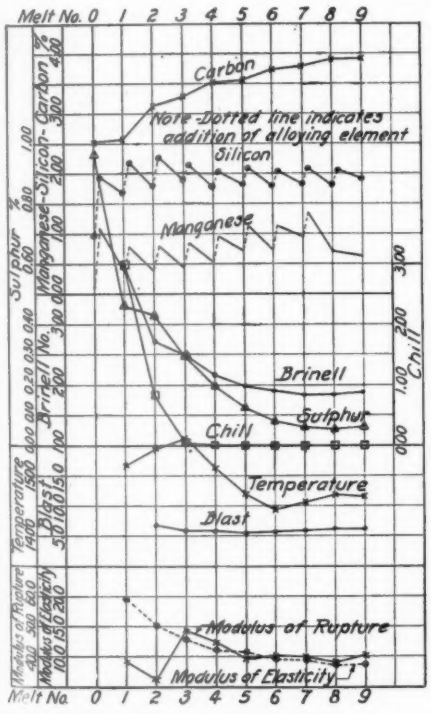

FIG. 5.—EFFECT OF REPEATED MELTING. (See Table VI.)

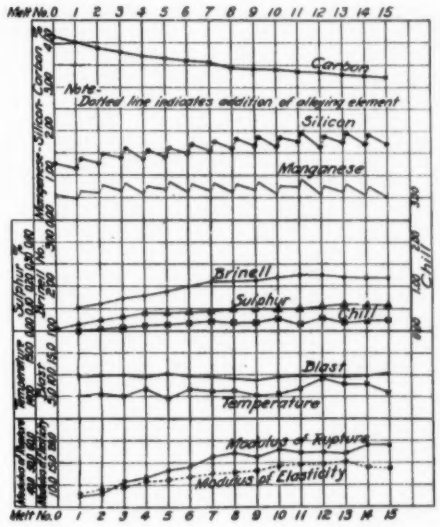
Melt No. 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Carbon
Note-Dotted line indicates addition of alloying element
Silicon
Manganese
Brinell
Sulphur
Chill
Blast
Temperature
Modulus of Rupture
Modulus of Elasticity
Melt No. 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

FIG. 6.—EFFECT OF REPEATED MELTING. (See Table VII.)

TABLE IV.—*Physical and Chemical Data on Cokes Used in Investigation.*

Symbol.	Kind.	Temp. of ignition, Deg. C.‡ Min.	Max.	Avg.	Mins. for 250 deg. Fahr. rise.‡	Max. temp. rise, deg. Fahr.‡	Shatter.§	Cell space.§	Ash. Per cent.	Volatile matter. Per cent.	Sulphur. Per cent.
R.H.	Special*	—	—	—	—	—	69	49	13.6	0.8	1.0
R.B.	Furnace*	562	604	585	2.6	256	63	49	14.6	1.3	0.9
W.B.	Furnace*	515	554	533	2.4	269	70	54	9.6	1.8	1.0
A.B.	Foundry*	568	624	590	2.9	241	73	49	10.0	0.8	0.6
Q.B.	Pitch† ..	493	537	518	1.4	350	88	47	0.4	0.9	0.4
H.C.	Foundry†	504	571	540	2.6	259	79	59	10.2	1.0	0.7

* By-P.—By-product oven. † B.H.—Beehive oven. ‡ Boegehold burning test. § A.S.T.M. tests.

Influence of Coke

Fig. 7 shows the comparative results on ABC (a good coke used regularly in the author's foundry) and pitch coke starting with different raw materials. Sulphur also tends towards an equilibrium if the manganese be kept constant. If the manganese be allowed to decrease, the sulphur rises to keep the product Mn × S constant. Fig. 8[2] shows how this constant varies with temperature. Carbon also has an effect on the Mn × S constant and *vice versa*. In the melt of the high-sulphur pig with pitch coke shown in Fig. 5[2] the carbon rose from 2.55 to 3.91 per cent. with a sulphur decrease of 0.905 (0.970 to 0.065) per cent., whereas the same pig with R.H. coke decreased only 0.825 (0.970 to 0.145) per cent., with a carbon increase from 2.55 to 2.95 per cent. The relation between carbon equili-

* Proc. Inst. Brit. F., 1937.

brium and ash is shown in Fig.9[3], and that between the Mn × S constant and the total sulphur is shown in Fig. 10[3]. This Paper is much too long and involved to be presented in any further detail here, but it may be worth while to quote the conclusions:—

"103. Different cokes have a considerable influence on the carbon of the molten iron. In general, the ash content is a large factor; but differences of 3 or 4 per cent. ash can be quite overshadowed by differences in the burning rate or other characteristics of the coke.

"104. For ordinary cokes, the higher the temperature, the lower the carbon-equilibrium point. This probably is not true at either extreme of temperature, for pitch coke gives both high temperature and high carbon, while it is well known that a temperature low enough to cause oxidation gives low carbon. Whether this is due to oxidation during melting, or to reactions with the slag, is not known to the writer.

"105. Some cokes did not give the same carbon, irrespective of the original carbon content for the number of melts tried. In other words, the tenth melt of a pig-iron still had higher carbon than the tenth melt of a steel charge. Some cokes, however, gave the same carbon on the fifth melt of both pig-iron and steel.

"106. The time for 130 deg. C. rise in the burning test was high on the coke giving the highest carbon (except for the pitch coke). It showed a minimum carbon at 2.6 min. There were not enough points on the curve to be sure of this.

"107. Sulphur increases with the sulphur of the coke, all other things being equal.

"108. Manganese has a strong influence on the sulphur, especially around a critical point which depends on the other constituents of the metal and on the sulphur and burning characteristics of the coke.

"109. The manganese-sulphur product tends to remain constant with a given coke. It is raised by ferro-manganese additions and increases with the temperature.

"110. Carbon and sulphur are mutually repellent. A high-sulphur iron is difficult to carburise and, on the other hand, a low-carbon iron absorbs sulphur readily.

"111. A coke which gives low carbon gives a higher sulphur absorption than one of the same sulphur content which gives high carbon."

The work for the Paper on coke size[4] was also carried out in a small cupola (18 in. dia.) using a fan blower. Fig. 11 shows the comparative results for some shorter heats, which, however, give undue prominence to the results of the first few taps. The comparative results for the largest and smallest cokes are shown in Fig. 1, which gives the results on melts of pipe scrap for each element on each tap.

Effect of Coke Size

Evidently the effects of size tend to fade out as melting proceeds, except in the case of carbon, and here it is not particularly important on carbons approximating to the equilibrium point. In the Institute of British Foundrymen's Paper,[1] 2-in. coke gave 2.50 per cent. carbon on an all-steel melt, as against 2.17 per cent. for a 4-in. coke. The temperatures are shown in Fig. 12,[4] which indicates again that oxidation and temperature are tending to counteract each other in the case of the carbon. No effects of blast were observed other than those accountable for by the changes in analysis.

TABLE V.—*Data on Repeated Melts with Charges of* R.H. *Coke* (12½ *per cent.*) *and Steel, using* 34-*in. Bed and* 3 *per cent. Dolomite Flux.*

Melt No.	Added		Blast pressure.	Temp. Deg. C.	C.	Si.	S.	Mn.	P.	Ti.	Chill.		Brinell.	Mod. of rupture.	Mod. of elasticity.
	Si.	Mn.									Last white.	First grey.			
Orig.	2.90	0.80	—	—	0.40	3.08	0.045	1.12	0.20	0.45	—	—	—	—	—
1	0.00	0.00	6.4	1,503	1.74	2.40*	0.146	0.78	0.20	0.07	1.56	0.95	288	58.6	20.8
2	0.00	0.00	7.3	1,463	2.31	2.47	0.198	0.68	0.20	0.04	0.14	0.06	260	61.0	18.0
3	0.00	0.00	7.0	1,468	2.45	2.53	0.218	0.54	0.21	0.04	0.15	0.10	257	65.8	17.5
4	0.00	0.00	6.7	1,504	2.64	2.40	0.249	0.44	0.25	0.03	1.13	1.13	268	47.8	14.2
5	0.00	0.00	6.4	1,470	2.65	2.33	0.285	0.38	0.27	0.01	3.00	3.00	413	43.7	20.7
6	0.00	0.32	6.4	1,485	2.74	2.20	0.268	0.63	0.27	—	1.05	1.04	295	49.9	17.0
7	0.00	0.16	5.8	1,472	2.76	2.07	0.253	0.52	0.27	—	0.30	0.24	263	66.7	15.3
8	0.00	0.16	5.8	1,461	2.80	1.90	0.278	0.45	0.27	—	0.83	0.76	307	51.5	16.0
9	0.00	0.16	5.2	1,475	2.85	1.81	0.279	0.41	0.29	—	1.90	1.26	302	37.5	16.5
10	0.00	0.32	5.2	1,475	2.81	1.74	0.253	0.52	0.30	—	0.84	0.64	267	62.3	17·1
11	0.00	0.32	5.2	1,472	2.99	1.59	0.195	0.79	0.30	—	0.46	0.37	246	63.0	15.0

* Weighted average all taps gives 2.64 Si, 0.84 Mn.

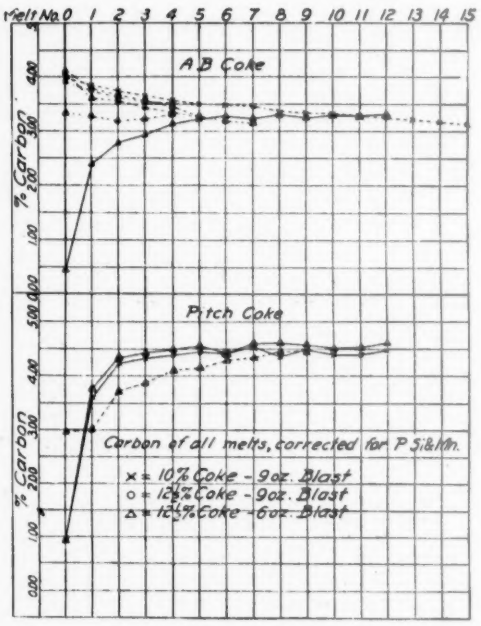
Melt No. 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
A.B Coke
Pitch Coke
% Carbon
Carbon of all melts, corrected for P, Si & Mn.
× = 10% Coke - 9oz. Blast
○ = 12½% Coke - 9oz. Blast
△ = 12½% Coke - 6oz. Blast

FIG. 7.—CARBON OF ALL MELTS, CORRECTED FOR P, SI AND MN.

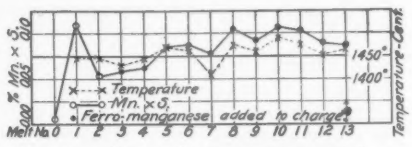

FIG. 8.—MN × S AS AFFECTED BY TEMPERATURE OF MELT. CHARCOAL PIG-IRON WITH 10 PER CENT. H.C. COKE (0.7 PER CENT. S).

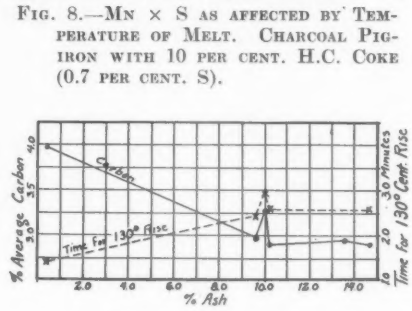

FIG. 9.—RELATION OF ASH CONTENT TO BURNING TIME OF COKE AND AVERAGE CARBON OF 8TH, 9TH AND 10TH MELTS.

TABLE VI.—*Data on Repeated Melts with Charges of* Q.B. *Pitch Coke* (12½ *per cent.*) *and High-Sulphur Pig, using* 34-*in. Bed and* 3 *per cent. Dolomite Flux.*

Melt No.	Added		Blast pressure.	Temp. Deg. C.	C.	Si.	S.	Mn.	P.	Ti.	Chill.		Brinell.	Mod. of rupture.	Mod. of elasticity.
	Si.	Mn.									Last white.	First grey.			
Orig.	—	—	—	—	2.55	0.97	0.970	0.10	0.85	—	—	—	—	—	—
1	1.00	1.00	N.R.	1,518	2.58	1.70	0.461	0.39	0.85	0.01	3.00	3.00	398	38.2	19.8
2	0.50	0.40	6.9	1,546	3.17	1.78	0.430	0.41	0.87	—	0.84	0.84	273	32.7	15.5
3	0.50	0.40	6.1	1,563	3.31	1.91	0.296	0.47	0.84	—	0.05	0.05	251	48.9	12.6
4	0.25	0.40	6.0	1,514	3.55	1.79	0.198	0.57	0.89	0.01	0.02	0.02	219	45.2	11.2
5	0.25	0.40	5.7	1,471	3.57	1.84	0.130	0.73	0.88	—	0.01	0.01	202	39.4	10.8
6	0.25	0.40	6.0	1,446	3.74	1.81	0.084	0.73	0.86	—	0.00	0.00	193	40.7	9.7
7	0.25	0.40	6.1	1,459	3.80	1.83	0.064	0.97	0.85	—	0.01	0.00	184	40.0	9.7
8	0.25	0.00	6.4	1,472	3.91	1.82	0.059	0.73	0.88	—	0.00	0.00	185	38.0	8.6
9	0.25	0.00	6.4	1,467	3.91	1.93	0.065	0.63	0.87	—	0.00	0.00	189	40.5	8.8

TABLE VII.—*Repeated Melts, Charges* A.B. *Coke* (10 *per cent.*), *Charcoal Pig.*

Melt No.	Added		Blast pressure.	Temp. Deg. C.	C.	Si.	S.	Mn.	P.	Ti.	Chill.		Brinell.	Mod. of rupture.	Mod. of elasticity.
	Si.	Mn.									Last white.	First grey.			
Orig.	—	—	—	—	4.13	1.26	0.011	0.57	0.51	0.02	—	—	—	—	—
1	0.00	0.00	9.6	1,400	4.01	1.16	0.035	0.48	0.49	0.02	0.01	0.00	153	34.7	7.8
2	0.20	0.16	9.9	1,407	3.89	1.27	0.052	0.61	0.50	—	0.07	0.03	162	36.2	9.2
3	0.20	0.16	10.0	1,400	3.78	1.39	0.067	0.66	0.50	—	0.14	0.06	174	41.3	9.3
4	0.20	0.16	9.9	1,419	3.70	1.36	0.084	0.59	0.50	0.02	0.17	0.10	180	43.2	10.8
5	0.20	0.16	10.3	1,394	3.64	1.41	0.083	0.68	0.52	—	0.21	0.12	188	46.4	11.1
6	0.20	0.16	9.8	1,419	3.58	1.49	0.087	0.63	0.49	0.01	0.23	0.15	201	48.0	11.9
7	0.20	0.16	9.8	1,413	3.57	1.55	0.094	0.66	0.47	—	0.30	0.16	212	52.8	12.6
8	0.20	0.16	9.3	1,413	3.44	1.61	0.103	0.63	0.49	—	0.24	0.15	212	54.2	12.8
9	0.20	0.16	9.0	1,403	3.42	1.66	0.101	0.68	0.50	—	0.25	0.15	215	52.2	13.2
10	0.20	0.16	9.6	1,407	3.40	1.64	0.101	0.60	0.49	—	0.35	0.23	221	55.8	14.3
11	0.20	0.16	9.8	1,419	3.33	1.74	0.099	0.73	0.52	0.01	0.20	0.12	225	54.2	14.7
12	0.20	0.16	9.9	1,442	3.34	1.64	0.114	0.58	0.52	—	0.40	0.24	225	54.6	14.7
13	0.20	0.16	9.6	1,428	3.27	1.74	0.120	0.64	0.51	—	0.26	0.14	221	53.8	51.1
14	0.20	0.16	9.9	1,430	3.24	1.70	0.120	0.57	0.53	—	0.29	0.20	220	58.4	14.0
15	0.20	0.16	10.4	1,410	3.20	1.70	0.117	0.52	0.52	—	0.30	0.23	222	57.6	14.0

Melt No. 1—O 0.005, N 0.013. Melt No. 15—O 0.014, N 0.007.

Effect of Coke Ratio

A few tests have been made on changes in coke ratio without other changes. These show that carbon and sulphur pick-up increase and manganese and silicon losses decrease as the coke is increased. A change from 25 to 35 per cent. of pitch coke on all-steel charges raised the carbon from 3.38 to 3.98 per cent., and the sulphur from 0.086 to 0.105 per cent. Manganese and silicon were added as rich ferro-alloys, 80 and 50 per cent., so the results are not reliable, but apparently the effect is rather small on these two elements. Fig. 1[4] shows a very distinct gain in silicon when starting with a high bed using small coke, and silicon losses are commonly quite low when using high coke ratios of 12 to 16 per cent., but manganese, on account of its reaction with the increased sulphur, and due to actual volatilisation at high temperatures, tends to lose

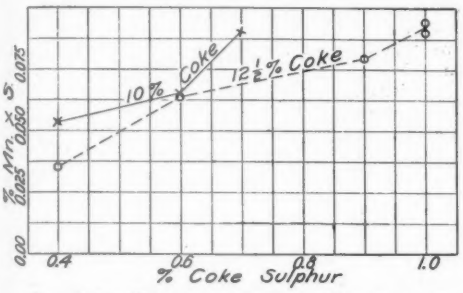

FIG. 10.—RELATION BETWEEN SULPHUR OF COKE AND Mn × S ON 8TH, 9TH AND 10TH MELTS.

at a more nearly constant rate. If the blast be increased to give the same melting rate, an increase of coke scarcely affects the analysis at all.

The blast pressure (volume) has also been investigated. It has been observed for some years at the author's foundry that relatively enormous changes in driving rate can be made without any significant changes in the charge and the composition of the melted iron; for instance, blast pressures of from 10 to 30 ozs., with a consequent change in melting rate from 15 to 25 tons without changing the charge, the coke ratio (except adjustment of the bed height) and with no resultant change in the analysis of the iron. In order to check this more accurately, the tests

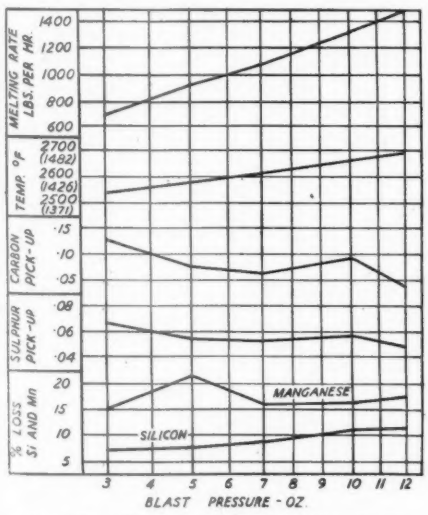

FIG. 13.—EFFECT OF BLAST PRESSURE ON MELTING OF PIPE SCRAP.

shown in Figs. 13 and 14 were run. The first material was a cast-iron scrap charge, and the second was a high-silicon steel cast into pigs for these tests. These were on a 21-in. cupola (with a positive-pressure blower), hence the relatively low blasts. By far the most important effect was on the temperature, although the manganese and silicon losses increased slightly and the sulphur pick-up decreased slightly with increased blast. The carbon lost slightly on the 3.40 per cent. carbon scrap and gained slightly on the low-carbon (0.65 per cent.) steel. Probably increase in oxidation tends to reduce the carbon, but the increase in temperature prevents it.

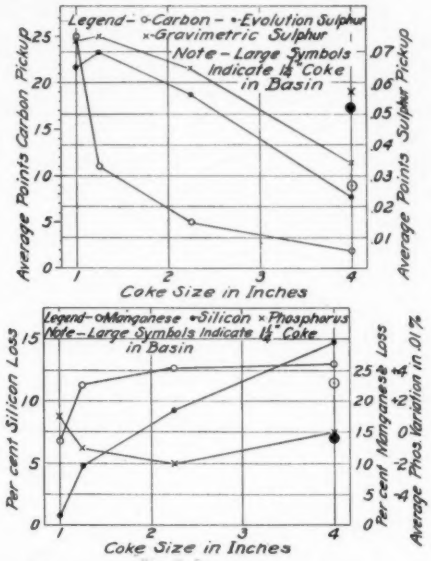
Legend– ○Carbon – •Evolution Sulphur
×Gravimetric Sulphur
Note – Large Symbols Indicate ¼" Coke in Basin
Average Points Carbon Pickup
Average Points Sulphur Pickup
Coke Size in Inches
Legend– ○Manganese •Silicon ×Phosphorus
Note – Large Symbols Indicate ¼" Coke in Basin
Per cent Silicon Loss
Per cent Manganese Loss
Average Phos Variation in .01%
Coke Size in Inches

FIG. 11.—AVERAGE CHANGES IN ANALYSES WITH EACH SUCCEEDING CHANGE IN COKE SIZE.

Influence of Size of Steel Scrap

A great deal has been shown incidentally in the previous discussion, and especially in the details of the several Papers as to the effect of the composition of the charge. One test on size of steel[4] as charged may be of interest. Three sizes of steel scrap were melted, with results as shown in Table VIII. These tests were made with 4-in. coke which was somewhat too large for the 18-in. cupola but the results are interesting. Neither the large nor the small steel gave the best results for carbon pick-up, but the difference in sulphur is quite consistent. The silicon and manganese were again added as rich alloys and are only approximately indicative of what was going on. A personal view is that the large pieces of steel melted too

TABLE VIII.—*Influence of Type of Steel Used as a Raw Material on Composition and Transverse Test.*

Load.	C.	Si.	Mn.	S.	Test-bar.	
					Load.	Defl.
					Lbs.	Ins.
3½ in. round steel ..	2.18	1.38	0.40	0.097	4,100	0†31
¾ in. round steel ..	2.34	1.63	0.53	0.124	4,100	0.29
½ in. to ¼ in. strip ..	2.07	2.20	0.30	0.145	3,600	0.26

slowly and reached so far into the bed that it was slightly oxidised, while the thinner material melted high but in such a number of small drops that it was oxidised on its downward path. The medium steel melted at the top of the normal melting zone and came down in large drops, thus escaping oxidation. The silicon outran the large pieces of steel, while the oxidation and high sulphur of the finer grades of steel used up the manganese of the melt. Certainly, the writer can testify that the melt from the fine steel was wild. The results of the test-bars confirm this, for bars from the thin steel were weak compared with the others, largely due to unsoundness. With fine scrap it is often economical to increase the bed height and coke ratio, which protects it from oxidation and pays by increasing the amount of molten iron recovered, saving of the lining, and generally increasing the smoothness of operation of the cupola besides giving a quiet melt and sounder castings.

It seems that there might be a difference in the carbon of the melt whether the charge of a given carbon content were made up of a uniform material like a special low-carbon pig or a mixture of high-carbon pig and steel scrap. To confirm this a cast was made of some 3 per cent. carbon pig (pig-iron + blown metal) and tests were made. The average result of two heats of 3 per cent. straight pig and 3 per cent. mix (25 per cent. steel and 10 per cent. cast-iron scrap) gave 3.27 per cent. C for pig-iron and 3.32 per cent. C for the mixture. The sulphur showed the same on both—0.035 per cent. pick-up; the manganese loss was 11 per cent. (of 0.75 per cent.) for the pig and 17 per cent. for the mix; and silicon lost 0.09 per cent. out of 1.60 per cent. for the pig and 0.23 per cent. on the mix. These results are the average of five heats on each mix on the 72-in. by 102-in. cupolas, each representing about 250 tons.

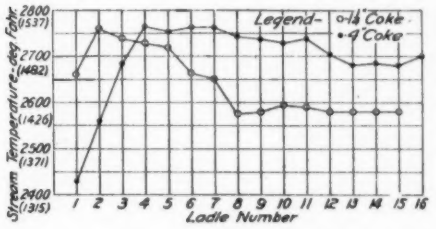

FIG. 12.—VARIATIONS IN TEMPERATURE IN HEATS OF LONG DURATION WITH VARIOUS SIZED COKES.

This Paper is submitted to the Institute of British Foundrymen with the best wishes of the American Foundrymen's Association and the hope that it will help to clarify some of the ideas as to what happens in the cupola. The

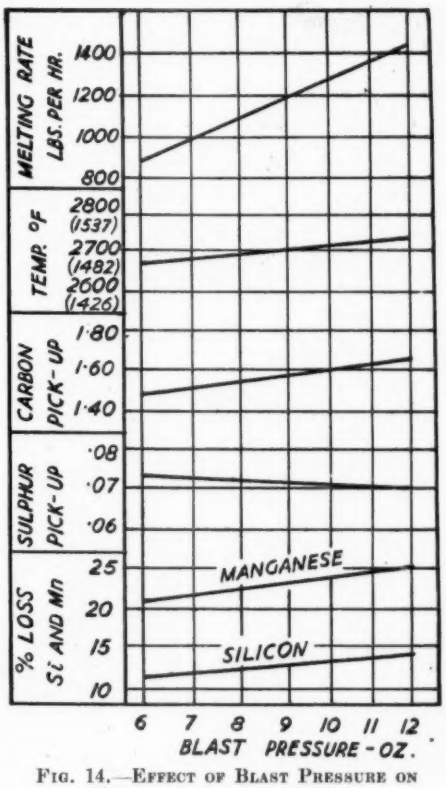

FIG. 14.—EFFECT OF BLAST PRESSURE ON MELTING SILICON-STEEL PIGS.

statement of complicated inter-reactions given in the first part is not meant to frighten the beginner but rather make him pause before arguing from some one law of physics or chemistry to the exclusion of so many others—

(*Concluded on page 54.*)

English and American Steel-Foundry Practice

By C. J. DADSWELL, Ph.D., B.Sc. (Eng.), Ingénieur de l'Ecole Supérieure de Fonderie

(*Continued from page 34.*)

Heat-treatment Methods

Most of the heat-treatment furnaces used in the steel foundries of America are fired either by oil or natural gas, as against coal, producer gas or town's gas in this country. In America most small castings are heat-treated by normalising, with or without subsequent tempering. The heavier castings are, of course, annealed and cooled in the furnace, although it is noticeable that for very large castings the rates of heating and cooling are rather higher than those used in Sheffield. It is not likely that the difference in the rates can be attributed to any better scientific knowledge, but is probably due to the fact that with the smaller output in this country furnaces have been available to permit one to play safe with large masses, whereas in America the output has probably increased until they have been forced to speed up the annealing, apparently with success.

Whereas large cast-steel anvil-blocks weighing from 20 to 100 tons made in British foundries are annealed, American opinion on the subject is divided; some steel foundries anneal big anvil blocks while others allow them to cool down over a long period in the moulds, as in the case of cast-iron blocks.

An interesting procedure in at least two American foundries is the differential hardening of different parts of small castings, to obtain improved wear resistance.

Fettling and Cleaning of Castings

The fettling shop methods or processes in both countries are similar, excepting that in certain cases in America the fettling shop can be very much better organised than in this country, as fewer types of castings pass through one particular shop. This makes it easier both to arrange for flow production and to set up a satisfactory organisation, which in the case of a fettling shop is as difficult a problem as any encountered in foundry management.

An example of an American conveyor line, where castings up to half a ton in weight, resting on grids, travel on gravity rollers past the various fettling operations, is shown in Fig. 16, whilst Fig. 17 illustrates one of the few conveying systems which have been installed in English fettling shops.

High-pressure compressed-air shot-blasting is becoming common in this country and is widely used in America. British foundrymen are also following the Americans in extending the use of the airless centrifugal shot-projector cleaning machines, the merits of which have been rapidly recognised in both countries. Whereas in England this type of machine has always been supplied in the form of a tumbler, or in its modified apron-conveyor form, excepting in one installation already in operation and in a further plant to be installed in the foundry with which the author is connected, the centrifugal airless shot projector has been applied in America to several types of special machines for specialised work. This is again because the justification for spending money on such elaborate equipment has arisen there more readily than in this country. One extremely interesting example of this application is the specialised cleaning of bogie castings weighing about five hundredweights each, which are cleaned at the rate of one every two minutes. Apart from the use of this method of cleaning on account of its economy in air and its convenience, the American manufacturers have been as interested as is the case here in its relation to the problem of silicosis.

The present attitude in America towards silicosis is very keen, and everything is done towards the elimination of this disease, some works having their own X-ray apparatus in the works first-aid department for keeping a check on all workers. This keenness is due to legislation, and has been increased because many foundries have been the victims of certain types of compensation cases.

In view of the recent Factories Act in this country, the provision in many American foundries of works welfare equipment in the form of canteens, washing and locker accommodation is interesting. This equipment is better than that generally provided in our foundries, being equivalent to the type of accommodation installed at many modern colliery pitheads in this country. Particular attention is paid to the wearing of goggles, and all staff, foremen and even visitors have to wear goggles when passing through the fettling shops.

Labour Conditions

The question of labour in America, how much a man earns, how freely he spends his money, how he works and how he compares with the British labour would make the subject of a very interesting Paper in itself. There are many good workmen both in America and in this country, and in making comparisons one must consider conditions. Often comparisons are made without due consideration for this. The British workman, working on a production line with the opportunity to earn good money, will produce as much as the American, but so often comparisons are made between the American workman under production conditions with the British workman under jobbing conditions. Those in charge of foundries making motor car components are perhaps better able to express an opinion on this matter than the author. Trade Union conditions in America are not like those in this country, and at the present moment are causing the employers some anxiety. This is partly due to the fact that the Trade Union growth in that country is much more recent than here, and also to the very mixed races comprising American labour, coupled with political influences which it is out of place to discuss here.

FIG. 16.—AMERICAN FETTLING SHOP CONVEYOR LINE.

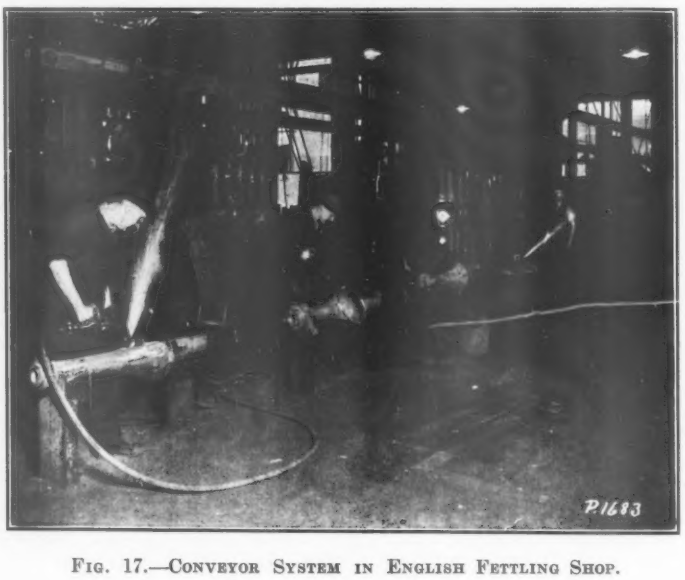

FIG. 17.—CONVEYOR SYSTEM IN ENGLISH FETTLING SHOP.

Foundry Research

There is no doubt that in the post-war period the steel-foundry industry has advanced a long way both in Great Britain and in America, but the author is of the opinion that the Americans have moved relatively somewhat farther than is the case here. There are several reasons why this should be, one being the influence of specialisation which has been mentioned several times, and another that there are many more steel foundries in America than in England, and therefore more people giving thought to its products. A further important reason is that more time and money have been devoted to research in America. Apart from the larger concerns having devoted a certain amount of energy within their own organisations to this end, certain of the smaller foundries have grouped their resources, one instance, in the author's opinion, having been very fruitful. This was the Electric Steel Founders' Research Group, which was supported by five different concerns. A visit to three of them showed such a high standard generally in all their operations and in their finished products as to give convincing evidence of their

(*Concluded on page 52.*)

The Randupson Process of Cement Moulding

VIEWS AT BRADFORD CONFERENCE

When Mr. F. W. Rowe presented his Paper* on the Randupson process before the Bradford Conference of the Institute of British Foundrymen, very great interest was aroused. The discussion in the main centred around such practical aspects as box elimination and preparation of the cement sand mixtures. It was opened by MR. E. LONGDEN, who, after paying tribute to Mr. Rowe and his firm for having taken on so wholeheartedly a moulding system which was described as revolutionary, pointed out that in the foundry industry nothing so far disclosed could be described as revolutionary. Most executives who had been in the industry for the last ten to twenty years would have tried almost everything, including the cement process, which he would not go as far as to say had been found useless; perhaps, through lack of perseverance foundrymen had not reached such a high state of efficiency as claimed for the process in Mr. Rowe's Paper.

A Practical Reaction

He thought it was due to the foundry trade generally that there should be a thorough airing of this very special phase of foundry practice. It touched very keenly the practical side of foundry work. When the Paper was published foundry executives throughout Britain might be receiving requests to look into their supposedly out-of-date moulding practice and go ahead. Some individuals connected with foundries would try anything once, whatever it might be, but it could prove very dangerous and expensive. His criticism must not be misconstrued that he was against change. The hazards of the trade necessarily made one cautious of claims to revolutionary changes in the foundry. The first illustration in the Paper, Fig. 2, showed the arrangement for reinforcing a cement mould for a very small gear centre casting. Was there any foundryman who valued the appearance of a small casting, or who operated moulding machines, or ran a continuous casting plant, who would for a moment look twice at the cement process? Was it possible to secure equally good-looking castings in cement? Was it possible to obtain the smooth running of the elastic system which obtained with sand in the normal moulding practice?

A Steel Gear Casting

After ascertaining from Mr. Rowe that the mould described in Fig. 2 was for a steel casting, Mr. Longden agreed that there might be some small justification for making the mould in cement, if one considered from the Paper as a whole that steel came out favourably in this process. But later in the Paper reference was made to the elimination of moulding boxes. What, then, was the use of trying to save the use of moulding boxes if from six to twelve loose irons must be introduced into the very small cement mould to hold it together? To his mind, that was not going forward, but in circles. Mr. Rowe admitted that he was not too happy with the economy of cement-bonded sand for small castings.

Time Cycle

Then there was the question of the cycle of operations which called for a setting time of from one to two days, which was rather alarming when compared with the steady running of normal sand moulding with its continuous sequence of operations. The fact that so wide a range of setting times as from 24 to 48 hours was needed was a set-back to the foundry. After all, unit production per unit area of the foundry floor reflected on the on-cost charges. It influenced the cost of castings where the floor area was large and there was a small *pro rata* output.

Roll Castings

Referring to Fig. 5 showing a cement mould for a roll casting, for which much was claimed as having been cast on end without moulding boxes, Mr. Longden said that one could nearly count the numerous wrought-iron or steel rods embedded in the cement sand. It was not thought to be an improvement to abandon the use of moulding boxes (which were normally available). One could identify, from the illustration, 40 circular irons, and there might be as many vertical ones, many of which could be also seen. To bend irons and bed them in a mould and handle them from point to point was time-absorbing. What about the cost of the irons?

Moulding Box Costs

There was also expense for the wooden boxes to make the mould. After the cement had been knocked off the outside the irons were disclosed, showing that very considerable reinforcements were necessary to withstand ferro-static pressure. With ordinary moulding boxes the same mould could be made without a single iron. The clamping of moulding boxes was also less costly than clamping cement sand moulds. The amount of tackle that the system demanded quickly cancelled out any possible saving in moulding boxes.

The precision with which ordinary moulding boxes went together and the accuracy of the joints of the mould were very important. The moulding costs would be increased by the time of setting the cement parts together and that was a considerable item. Again, dressing charges might be increased due to the irregular joints on the casting made by putting cement blocks together.

Auxiliary Labour

With the cement process there was a serious cost in sand mixing and ancillary labour, whilst the cement itself was not cheap. Mr. Rowe had himself outlined the many disadvantages as well as the advantages of the process. The advantages which the speaker appreciated were concerned with the possibility of reducing swelling of the casting if of large dimensions and elimination of drying by artificial means, although this last advantage was doubtful in view of the long setting time. But was the cement mould free from the usual hazards which surrounded normal sand practice?

The Time Element

It had been pointed out that danger arose if too much water was introduced into the cement sand mixture. The proper setting time was between 24 and 48 hrs., depending upon the class of mould, and the cement sand took on a secondary and more permanent and stronger hardness after about 24 days. This would exclude the production of the very large class of casting taking more than about three weeks to make.

Hardness and Surface

The mould would be so hard that it would have to be broken up by a tup. The hard set of the mould was against a fine surface finish and easy repair to the face of the mould. A serious repair to a mould, which was not uncommon, would require the setting time over again.

Were moulding boxes eliminated, as claimed? On most of the illustrations one could see, more or less, moulding boxes employed for cement moulds.

It was stated that cores did not need cast core grids. But was this time-saving? Was there not more time taken in arranging loose irons and their wiring than in stamping out a simple grid on the foundry floor. The speaker suggested that the hauser-pipe core shown in Fig. 14 would be more cheaply and safely made by using a cast grid. The hawser-pipe mould was enclosed in a moulding box, it would be noted—it was not cast without the ordinary moulding box as stated in the Paper.

Largest Weight and Section

The manganese steel mould was made with section cores, otherwise it would be too long to let the mould stand, perhaps reaching the secondary hardening. Would Mr. Rowe be kind enough to give more information about the large casing casting he referred to? Could Mr. Rowe state the weight and section thickness of the largest casting he had made, but not included in the illustrations? The casting was a piecework job for which, under normal sand practice, 120 hrs. was given to two skilled men.

MR. ROWE said the casting was 4½ tons weight and had a general section of ⅞ in.

Labour Costs

MR. LONGDEN said the question was involved by the introduction of "helpers." A piecework time of 45 hrs. was given in the cement process to one skilled moulder and three helpers. It was often difficult to find out the cost of castings made under new systems. There was a tendency when a new process or article was introduced to prove its worth by giving every help and facility not yielded to the normal method.

The three helpers should really be included in the prime or first cost, and this was in relation to the 120 hours given to two skilled moulders on the normal practice.

MR. ROWE said that the 45 hours was the total time spent by one skilled man and three labourers making a mould.

MR. LONGDEN: Roughly, the men would make time and a-half?

MR. ROWE: Yes.

MR. LONGDEN: Would they make time and one-half on both classes of moulds?

MR. ROWE: Yes.

MR. LONGDEN: How much time was spent by the core maker on the job?

MR. ROWE: Probably a day.

MR. LONGDEN observed that the saving in time at the best was in the shortened ramming time. All other operation times could not be cut. Information had been given of the acceleration of delivery time in the cement process if more than one casting was required of the same pattern. Surely that was a question, really, of sufficient moulding tackle. If one could go on making one cement mould after another, one could do the same in the ordinary practice. He thought the real intention was to infer that delivery time was accelerated apart from the saving in ramming time.

Again, it was all a question of the reasonable provision of foundry tackle. After all, there could be no saving in ramming against a mould rammed mechanically. In the cement process there was the disadvantage of weakness in the green state compelling more extensive use of rodding. Might he ask why, with an iron casting, a mould was coated with refractory and no coating was required on a steel mould which was poured with a much higher melting point metal? It was stated that, if blacked, a mould would air dry in six hours. Thus, a mould would occupy the foundry floor 24 to 48 hours for setting and 6 hours for blacking, unless hastened

* See FOUNDRY TRADE JOURNAL, June 23, 1938, pp. 520-6.

by artificial drying processes. Finally, Mr. Longden asked Mr. Rowe whether the cost of the castings was lower with the cement process than by the previous ordinary and standard practice.

A Well-Established Process

MR. ROWE suggested that Mr. Longden had not read the Paper—short as it was—with the care he would have liked him to do. The proof of the pudding was in the eating. There were no less than 4,000 tons of castings per week being made by cement moulding up to the present time. There were some 37 different companies operating the process, and, of course, some of them might be fools, but it was hardly likely that all of them were. He (Mr. Rowe) did state very clearly that, in his own personal opinion, and he was only voicing his own personal opinion, the process was not suitable to compete with green-sand moulds.

Reduction in Ramming Time

Mr. Longden had stressed the disadvantage of the long setting time, but that was one of the points he (the speaker) had emphasised in the Paper, yet there were hundreds of types of pattern which neither the speaker nor Mr. Longden nor anyone else could ram up in a week, which one could ram up in cement in a day, and that was very definite. How far that was favourable to one's own work was a matter of individual taste, or individual requirements of the very different foundries. Personally, he would be the last to put the process forward as the be-all and end-all of foundry work, but in considering the question of the long setting time, one had to take into account the saving of ramming up the ordinary mould; it was the saving on the ramming up in the quantity order which reduced the time taken to make a multiplicity of moulds.

Ironing *versus* Cast Grids

As regards the question of ironing, and the amount of ironing required, it was something for the individual foundryman to decide for himself as to whether the time required for ironing outweighed the advantages of the system. He was sorry that Mr. Longden thought fit to query the core for the hawser-pipe as having core grids in, because he did not think Mr. Longden had any evidence there to go on at all, and he could assure Mr. Longden that cores much more difficult were regularly being made without cast core grids with loose irons and no wiring. Moreover, it suited the speaker's conditions better to make them with irons rather than cast core grids. The largest castings made by this process were 50 to 60 tons in weight, though his had not exceeded 15 tons.

As regards blacking moulds, it was stated quite clearly in the Paper that moulds for cast iron had to be blacked, because the fluidity of the cast iron, or phosphor-bronze, was so great that with this highly permeable sand one did not otherwise get a smooth skin.

Mould Breaking Costs

MR. SPRIGGS said he had had the privilege of seeing the Randupson foundry, and it was surprising to him that more foundrymen had not tried the process. There was no doubt that Mr. Rowe had made a success of it, and that he made good castings was well known. The author had very frankly given a list of disadvantages, and the speaker was aware that Mr. Rowe had taken very effective steps to deal with these disadvantages by organisation and mechanical means. One point which he had not enumerated was the cost of breaking up the moulds. That appeared from a very casual personal observation to be quite an item, and definitely a disadvantage to this class of work. Then the previous speaker had said it was a question of economics. He believed that Mr. Rowe did claim that there were savings in the process, but apart from other advantages, such as unskilled labour and so on. He employed a quantity of mechanical means; in fact, from the illustrations it could be seen that his foundry was at any rate partially mechanised, and it would be interesting to learn whether he based his savings on floor moulding, the floor where the sand was made up, without mechanical means, or whether he would get the savings if he compared with another foundry having an equal amount of mechanisation to his own plant.

Floor Moulding Jobs

MR. ROWE said he regretted that he did not mention in the Paper the disadvantage of breaking up the moulds, which certainly one had to take into account. He had tried as far as possible to be fair and unbiased and unprejudiced about the process, and he had named the disadvantages, and the breaking up of the moulds was one that at the present time he was overcoming by mechanical means. The whole of the moulds could be crushed, and the sand recovered, without any serious cost.

In regard to the comparison of costs and the effect of mechanisation, as far as possible in the illustrations he had chosen jobs made on the floor, by ordinary methods, and jobs which were still made on the floor. He was afraid he could not do more than reiterate that the greatest advantage was the extremely rapid moulding times on jobs and the rapidity with which numbers of castings from medium and large sized patterns were made where only one pattern existed, and the fact that less care needed to be exercised in making the moulds than in the normal processes.

Skill Retention

MR. COOPER asked whether it was the policy of the Institute to reduce to an absolute minimum the amount of skill required. He did not think that it was. He thought the object was to retain the skill of the moulder and the people connected with the foundry at the highest possible level of efficiency, so that when a difficult casting was to be made, there were the skilled men available. He would like to ask Mr. Rowe whether, if he went to another foundry, he would have confidence in applying the same process. He knew that at his present foundry there had been adaptation exclusively for this, and it had ample space. Would he have the confidence to apply the process to another foundry which was successfully making steel castings at the present time?

MR. ROWE, in reply, asked if he would be wrong in saying that Mr. Cooper's object was to keep foundry work as difficult as possible?

MR. COOPER explained that he meant that skilled men were essential. He did not mean to make it difficult at all, but experience was necessary.

The "Normandie" Castings

MR. ROWE said that, so far as introducing the process to another factory, of course his firm was only one of many licensees of the process, and it was interesting to note that stern and stem posts for the "Normandie" were cast by this process. Steel castings up to 70 tons in weight were being cast by the process every day and many of them were most difficult and intricate castings. He had not had the advantage of personal acquaintance of making very large steel castings of that type, but those were merely shown to illustrate that the field was not restricted by the size or intricacy of the castings concerned.

Ingot Mould Making

MR. ROBERT BALLANTINE said that the Randupson process for ingot mould production had particularly interested him over a period, and more so since the Valley Mould Company in America had adopted the system. In the firm with which he was connected (the Fullwood Company) they cast as much as 200 tons per day, but, he understood, the American concern reached 500 tons per day. In view of this huge total cast, it would appear that the process was highly successful, but on the question of costs he was sceptical as to whether the introduction would effect economies as compared with the existing dry-sand system.

Was it essential for the roll shown in Fig. 4 that the mould should be built up in sections; further, could it be jolted and dried successfully as a unit?

Jolt-Ramming Cement Sand

MR. ROWE, referring to the large roll casting, Figs. 4, 5, 6, *et seq*, said that it was quite possible to jolt-ram with cement sand. At the foundry in question quite large moulds up to 15 or 20 tons in weight were being jolt-rammed in cement sand. He had not the advantage of knowing just how the Valley Company made their ingots, but he did know that they were producing somewhere between 2,500 and 3,000 tons of ingot moulds and the like per month, exclusively by the cement sand process.

Mould Permeability

A MEMBER asked what effect the cement sand would have on the hands of the moulders, and whether, in Fig. 1, the curve could be taken in conjunction with Dr. Dadswell's Paper in regard to maximum permeability.

Skin Effect

MR. ROWE said that people who had not been used to working with cement sand certainly, for the first few days, found that it did cause some irritation of the finger-tips; but when they had been working for probably two or three weeks, the trouble disappeared. His foundry had something like 200 men working in it all day long, and there was no difficulty at all on that score.

With regard to permeability figures, the ordinary tests were not suitable for the Randupson process, since the permeability, as far as one could see, was something like three to four times as high as the best permeability figures recorded with ordinary moulding sand. That, of course, was one of the great features of the process, that the permeability was so high. As a matter of fact, one of the demonstrations that the original licensees had been doing to show the high permeability was to take an ordinary steel mould about 2 ft. sq. and pour a quart of water into it, and to cast within five minutes to demonstrate that, in spite of the large amount of steam generated, the permeability was such that the steam found exit without any trouble.

Contraction Strains

Replying to MR. HIRD, who asked if there had been any trouble with contraction strains, MR. ROWE said that that question raised a point which immediately came into people's minds when they saw those hard cores and a very hard mould. The core-making practice was exactly the same as one would adopt with ordinary sand, inasmuch as the centre, as far as possible, was either filled with coke or with portions of broken mould, and it was necessary to keep the thickness of the cement sand in the core to a reasonable maximum, something like 2 to 2½ inches.

Everybody was aware of the difficulties of contraction tears in steel castings, which were much higher than those in iron. People who had seen the author's foundries had always commented on the fact that the system demanded very much less bracketing on steel castings than was normally the case. With valve castings in particular there was no bracketing at all. The foundry was making quite a number of very light steel castings where again no brackets were used, and there was no trouble with contraction tears.

Moisture Control

A MEMBER asked Mr. Rowe where he recruited his labour. Were the men skilled in dry-sand work, or were they just people who came in new to the job? Was the control of moisture

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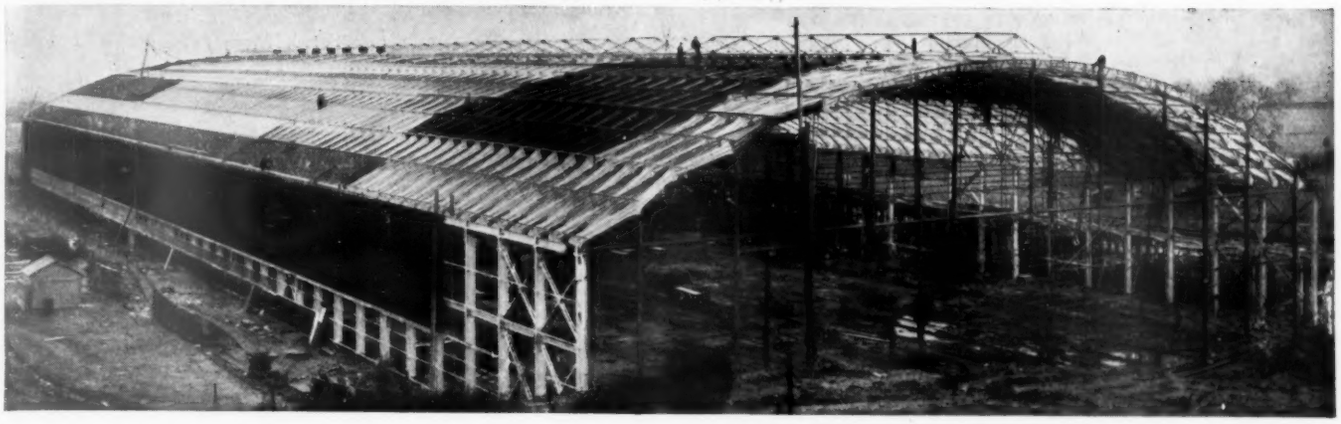

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very much more difficult when working this process than in ordinary green or dry sand?

MR. ROWE said he had a number of skilled moulders, and, of course, with difficult and intricate castings the skill of the moulder in finishing and knowing where to place his runners and where to iron the job and set in cores, and that sort of thing, was as much needed as ever, whether the cores and moulds were made of green sand or oil sand or any other type. The skill and experience of the moulder were required to put such castings together.

The moisture in the sand was controlled by frequent tests throughout the day to see that the moisture content of the sand was within the specified limits. Actually, the control of moisture was not so critical in cement sand, and variations of ½ per cent. up or down were admissible without any noticeable difference in the hardness or permeability of the finished mould. Working very largely, as he did, with recovered sand, it was dry and moisture free. It was quite easy working with new sand, using the ordinary type of water meter, to control the weight or volume of water entering.

Application under Abnormal Humidity Conditions

MR. P. BARRY PARKS said his company was in Hong Kong, and possessed a foundry where he was operating a battery of small electric furnaces. It was, unfortunately, situated in a very humid belt in which for a considerable portion of the year there was the abnormal humidity of sometimes 90 or even 100 per cent. He noticed one of the chief claims for this process was the advantage of natural drying, and he asked Mr. Rowe if he could give an opinion as to how the operation of the Randupson process would be affected under such conditions of abnormal humidity. He was chiefly concerned in steel castings, stern frames and rudder frames, and propeller brackets of about 5 tons. He had not had time to study the new process very carefully, having only been in this country a very short time; but it occurred to him that these abnormal conditions might seriously interfere with the effectiveness of the process. By a strange coincidence, one of his friends, Mr. Simpson, was also present from Hong Kong, and he thought he would verify the statements about the trouble occurring in foundry operations on account of this abnormal humidity.

The Case of the Alps

MR. ROWE said the process was far more influenced by temperature than by humidity. This had been fairly well studied, and humidity readings in various foundries of various licensees had been taken over fairly long periods to see how this affected the process. As a matter of fact, the foundry of the original licensees was situated in a very damp corner of the Alps, and the humidity there ranged from 85 to 95 quite frequently. As to whether a rather greater humidity, as was experienced in the visitor's foundry, would affect the process, it was somewhat difficult to be dogmatic; but he imagined with the greater temperature that they had there that the drying time would not be seriously affected by the increased humidity. Those who knew the mechanics of cement knew it was quite possible for this cement to harden in very damp atmospheres.

Catalogue Received

Paddle Wheel Fans. This simple type of fan is dealt with in the fullest possible manner in a new sectional publication (K 25) issued by Keith Blackman, Limited, of 27, Farringdon Street, London, E.C.4. Much fundamental technical data are included. The final pages are devoted to dust settlers and filters, matters of moment to most foundry executives.

Permanent Moulds for Builders' Castings

An article in a recent issue of "Iron Age" gives particulars of a permanent-mould machine for casting sanitary ware which has been developed and patented by Matthew Wagner, of M. Wagner, Inc., Glendale, Calif. The machine produces one casting per cycle and is used to cast 16 by 20 in. sinks and 20 by 24 by 13 in. wash basins. The principal construction features of the machine are illustrated in Fig. 1.

The machine is of semi-steel construction and has three main sections: the cope (A), the drag (B), and the core (C). Movement of the cope is provided through a hydraulic hoist, and a gear and ratchet mechanism is employed to lower and raise the core. The drag is mounted permanently on foundation supports and does not move. Vents, not shown in the drawing, are bored through the cope at strategic points to carry off the gases.

Preparatory to the casting operation, the mould sections are heated to about 150 deg. C. and coated with a refractory material. The sections are then closed and molten metal is introduced into the mould through the gate. The

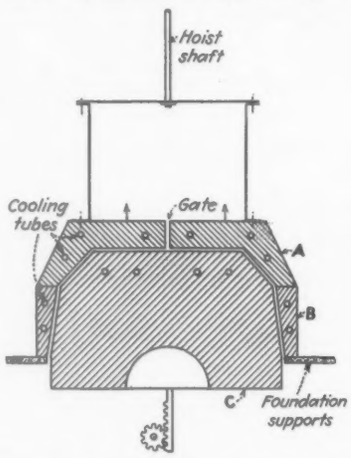


FIG. 1.—CONSTRUCTION OF PERMANENT MOULD MACHINE. A COOLANT CIRCULATES UNDER PRESSURE THROUGH THE PASSAGES INDICATED.

casting is given sufficient time to solidify, then the core is lowered and the cope raised. Simultaneously with the raising of the cope, to which the casting adheres, a plate mounted on wheels is pushed beneath the casting and a few light taps of a hammer on the gate head cause the casting to drop on the plate. Following the removal of the plate, the mould sections are closed and the cycle repeated. Two men are said to be able to turn out 30 castings an hour, or an average of one every 2 min. According to experience reported to date, the life of each mould is estimated to be about 10,000 pours.

One of the problems encountered in producing castings by this method is that of regulating the setting and cooling cycle to avoid having the casting contract over the core and shatter. Once the proper interval has been determined, and the other factors kept constant, casting becomes a routine matter.

Although the surface of castings produced in this manner is said to be minus the burnt-on sand common to the sand-cast product, it is necessary to sand-blast the castings to remove the mould coating and other dirt which is picked up between the mould and the enamelling ovens.

A DECLARATION OF SOLVENCY has been filed relating to the Bowesfield Steel Company, Limited. Authorised capital is £200,000 in £1 shares.

Pig-Iron and Steel Output

SEASONAL INFLUENCE

The British Iron and Steel Federation announces that there were 97 furnaces in blast at the end of June compared with 105 at the end of May, nine having ceased operations during the month and one having resumed production. Of the net decrease of eight in the number of blast furnaces blowing, four represent small, old-type stacks, retirement of which was notified in May, and two are provisionally damped down. The output of pig-iron was 541,500 tons, compared with 633,900 tons in May and 699,300 tons a year ago. The production of pig-iron in June included 121,600 tons of hematite, 303,000 tons of basic, 95,000 tons of foundry, and 11,200 tons of forge pig-iron. The output of steel ingots and castings was 776,100 tons, compared with 957,000 tons in May and 1,106,400 tons in June, 1937. The Whitsuntide break this year accounted for the loss of about two working days, taking an average over the whole industry. Production of steel for the first half of 1938 amounted to 5,926,500 tons, against 6,338,400 tons and 5,743,400 tons in the corresponding periods of 1937 and 1936 respectively.

English and American Steel-Foundry Practice

(*Concluded from page* 48.)

wisdom in so spending their money during the depression period.

As in this country, other researches are taking place under the direction of various trade and scientific associations. In this direction and in many others our American brother organisation—the American Foundrymen's Association—with its wide membership, has a large influence. Particular mention might be made of the activities in this country of the Steel Castings Committees of the Institute of British Foundrymen and of the Iron and Steel Institute, but the members of these committees are also busy foundrymen and scientists. Would it not give us a quicker return if groups of manufacturers or the Trade Association were to initiate a research council on the lines of the American Electric Steel Founders' Group, who would have certain full-time investigators working in collaboration with the previously mentioned committees?

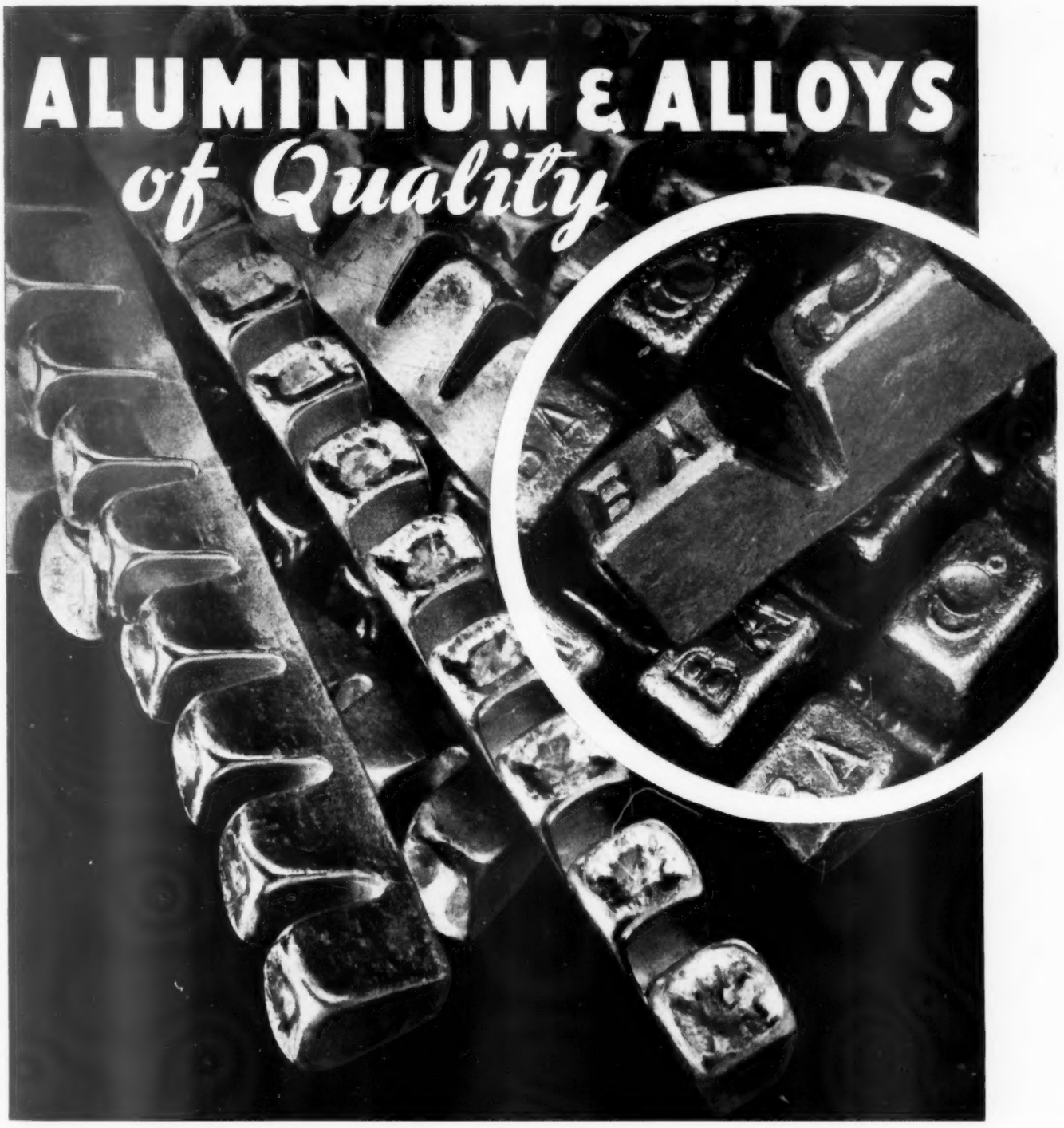
Conclusion

A visit to the United States of America to make a study of either a specialised steel-foundry production or a general survey of their practices is a most refreshing experience, and dispels the prevalent impression that their products are generally much inferior to British.

In view of the rapid developments that will still be made by our progressive friends, it is probable that one should renew acquaintance with their foundries every five years. Contact with them is very instructive, particularly, if one keeps a logical judgment regarding different conditions, without being too sceptical or sure that Britain is placed in such entirely different conditions that an adaptation of ideas is not practicable.

The reception accorded by the American foundrymen without exception to one of their own profession from this side of the Atlantic is as hospitable, instructive and helpful as one could possibly desire, and the author would like to take this opportunity of expressing his appreciation of the manner in which he was everywhere welcomed on his recent tour of American steel foundries.

The author wishes to express his gratitude to the directors of English Steel Corporation, Limited, for permission to present this Paper.



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The Week's News in Brief

Trade Talk

THE No. 1 blast furnace at the Renishaw Ironworks, Derbyshire, has been restarted.

THE SHOTTS IRON COMPANY, LIMITED, have temporarily damped down two furnaces to allow of extensive repairs.

THE INSTITUTE OF WELDING will hold its annual dinner this year at Grosvenor House, London, on Wednesday, October 26.

PRODUCTION is to start shortly at the new works on the Pallion Industrial Estate, Sunderland, of the Saturn Oxygen Company, Limited.

THE DARLINGTON FORGE, LIMITED, announce that their works will be closed for annual holidays from July 30 to August 6, both dates inclusive.

THE WORKS of the English Steel Corporation, Limited, at Sheffield and Manchester, will be closed for annual holidays from July 23 to August 1 inclusive.

HURST, NELSON & COMPANY, LIMITED, of Motherwell, have received an order from the L.N.E.R. for the supply of 250 wagons for service on the company's express fish trains.

THE PARK WORKS, Lockwood, Huddersfield, of David Brown & Sons (Hudd.), Limited, remain closed from Friday evening, July 15, until Monday, July 25, for the annual holidays.

CROMPTON PARKINSON, LIMITED, the electrical engineers and manufacturers, gave a garden fête at Chelmsford, on Saturday, July 9, to mark the 60th anniversary of R. E. Crompton & Company, one of the founder companies of the Crompton Parkinson combine.

THE WORKING PROFITS of the Mysore Iron & Steel Works during 1936-37 amounted to Rs. 1,38,828. The estimated working profits during the current and next year are Rs 1,25,000 and Rs. 1,00,000 respectively, the decrease being due to the fall in the market price of steel.

APPLICATIONS FOR SPACE in the Engineering and Hardware Section at Birmingham of the forthcoming British Industries Fair have been received from 625 firms to date, for an area of 273,000 sq. ft., compared with 612 applications for 257,000 sq. ft. at the corresponding date a year ago.

KNOWSLEY CAST METAL COMPANY, LIMITED, Titan Works, Trafford Park, Manchester, have purchased the goodwill, patterns, patents and the machinery of W. H. Baker, Limited, Phoenix Foundry, Wigan, and have transferred the patterns, etc., to their new works in Trafford Park, Manchester.

THE ANNUAL STAFF OUTING of H. M. Biggleston & Sons, ironfounders, of Canterbury, consisted of a week-end trip to Belgium. The party, numbering 42, visited several places of interest, including Ypres and the Canadian Memorial at Vimy Ridge.

SYRIAN CUSTOMS DUTIES on cast-iron pipes of any diameter and cast-iron joints more than 5 cm. in diameter have been fixed at 450 piastres per 1,000 kgs. gross, and on cast-iron joints 5 cm. or less in diameter at 25 per cent. *ad valorem* (under the "normal" tariff). The "normal" tariff rate formerly applicable to these goods was 11 per cent. *ad valorem*.

THE THIRD annual general meeting of the British Foundry School will take place at 3.0 p.m. next Tuesday, July 26, at Central Technical College, Suffolk Street, Birmingham, this being the building in which the Foundry School is housed. All interested in the work of the School are warmly invited to be present. Tea will be served informally after the meeting.

A NEW TYPE of lorry body, believed to be the lightest of its type, size and capacity ever built, which makes extensive use of light aluminium alloys, was demonstrated at Brentfield, London, on Tuesday by the Northern Aluminium Company, Limited. This design, stated to be the result of many years' metallurgical research and experience of road transport requirements, is suitable for any standard British chassis.

THE NEED for a balanced industry in Dundee is being urged by the National Union of Foundry Workers, which, with the trades council, is making representations to the town council in August to organise a campaign to prevent the migration of foundry work from Tayside. A few years ago there were eleven foundries employing 300 men in Dundee, whereas it is reported that there are now only 27 foundrymen engaged, several of the foundries having been closed.

A £10,000 ADVERTISING CAMPAIGN is to be launched by the British Electrical Development Association and the Electric Lamp Manufacturers' Association offering guidance to factory owners in connection with the requirements of the new lighting regulations of the Factories Act which came into operation on July 1. The Act lays down that "effective provision shall be made for securing and maintaining sufficient and suitable lighting, whether natural or artificial, in every part of a factory in which persons are working or passing." It also provides that "the Secretary of State may by regulations prescribe a standard of sufficient and suitable lighting." The campaign will offer free facilities for the expert testing of existing lighting in any factory and guidance for any alterations required.

Chemical Changes in Cast Iron in the Cupola

(*Concluded from page* 47.)

a fault too common with young technical graduates. There are, as has been shown, many compensating reactions, otherwise cupolas could not be run so successfully on an entirely empirical basis as they have been for many years. It is important to remember that, to the human mind, even three or four simultaneous variables are bewildering, and the only real answer in cupola practice is the result obtained with the materials and equipment available.

REFERENCES.

1 J. T. MacKenzie: "The Properties of Coke Affecting the Cupola Melting of Steel," Proc. Inst. Brit. Found., Vol. 20, 1926-27, pp. 46-56.

2 J. T. MacKenzie: "Carbon and Sulphur in the Cupola—Some Properties of Coke," Trans. A.F.A., Vol. 38, 1930, pp. 385-431.

3 H. V. Johnson and J. T. MacKenzie: "Effect of Tuyere Height on Carbon Pick-Up in the Cupola," Trans. A.F.A., Vol. 44, 1936, pp. 178-190.

4 J. A. Bowers and J. T. MacKenzie: "Cast Iron as Affected by Coke Size in Cupola Melting," Trans. A.F.A., Vol. 45, 1937, pp. 293-319.

Personal

MR. A. C. CROSSLEY, M.P., and Mr. H. D. Carter have joined the board of Crossley Bros., Limited, gas and oil-engine manufacturers.

MR. FRANK S. RUSSELL, with a view to leaving himself more time for other duties, and particularly for work he is undertaking for the benefit of the distressed areas in South Wales, has relinquished a number of his chairmanship or directorial positions, and, amongst others, those with International Diatomite Company, Limited, Llangennech Brick & Tile Company, Limited, South Wales Refractories, Limited, N. B. Allen & Company, Limited, and Moler Products, Limited.

Will

BATTY, AUSTIN, of Sheffield, a director of the associated businesses of A. Spafford & Company, Limited, and Barker & England, Limited, file and machine-knife makers £3,197

Obituary

MR. JAMES A. WHITE, who had been in the service of John G. Stein & Company, Limited, Bonnybridge, for 37 years, died on July 12 after a long illness. He was 76 years of age.

MR. EUSTACE ABEL SMITH, of Longhills, Lincoln, died in London on Sunday, July 10, at the age of 75. His business interests included the chairmanship of the Bryan Donkin Company, Limited, Chesterfield, and of the Mid-Lincolnshire Electric Supply Company, Limited.

Contracts Open

Cairo, August 25.—Pumping plant, etc., for the Egyptian Ministry of Public Works. The Department of Overseas Trade. (Reference T. 24,280/38.)

Capetown, September 28.—Pumping plant, etc., for the City Electricity Department. The Department of Overseas Trade. (Reference T.Y. 24,416/38.)

Montevideo, August 5.—Coal-dust extraction plant, for the State Electricity Supply and Telephones Administration. The Department of Overseas Trade. (Reference T.Y. 24,171/38.)

Wellington, N.Z., August 16.—Bitumen spraying plants, for the New Zealand Public Works Department. The Department of Overseas Trade. (Reference T. 24,289/38.)

Wellington, N.Z., November 30.—Wharf crane, for the Otago Harbour Board. The Department of Overseas Trade. (Reference T. 24,292/38.)

Company Reports

Davy & United Engineering Company, Limited.—Dividend of 7½ per cent. for the year ended March 31.

Head, Wrightson & Company, Limited.—Dividend of 7½ per cent. and 2½ per cent. bonus for the year to April 30 on the ordinary shares.

Aveling-Barford, Limited.—Net profit for the year ended March 31, £54,176; brought in, £25,392; taxation, £10,000; dividend of 8 per cent., tax free, on the ordinary shares; to general reserve, £20,000; carried forward, after preference dividend, £31,818.

Wellman Smith Owen Engineering Corporation, Limited.—Net profit for the year ended March 31, £34,060; income tax and N.D.C., £4,985; brought in, £14,126; interim dividend of 5 per cent., £7,771; final dividend of 5 per cent., £12,628; carried forward, £22,801.

New Company

(From the Register compiled by Jordan & Sons, Limited, Company Registration Agents, 116 to 118, Chancery Lane, London, W.C.2.)

New Jarrow Steel Company, Limited, Consett Iron Works, Consett, Durham.—Capital, £700,000. Subscribers: C. Cookson, E. J. George, R. Alsop, Sir Chas. B. Gardner and D. A. Stirling.

Applications for Trade Marks

The following list of applications to register trade marks has been taken from the "Trade Marks Journal":—

"LINCROME."—Iron alloys. Ruston & Hornsby, Limited, Sheaf Iron Works, Lincoln.

"MELITE."—Magnesium and metallic alloys. Magnesium Elektron, Limited, Abbey House, Baker Street, London, N.W.1.

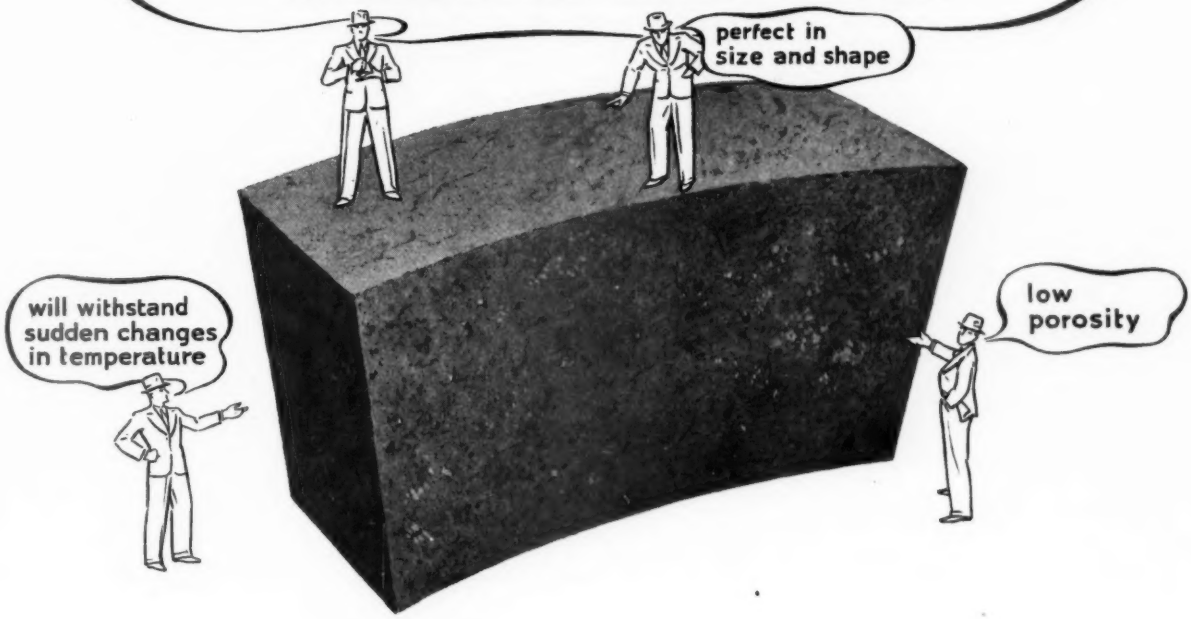
"K MONEL."—Nickel alloys. Henry Wiggin & Company, Limited, Thames House, Millbank, London, S.W.1.

"FELKRO."—Metals. R. J. Hunt & Son, Limited, Lifford Foundry, Breedon Cross, King's Norton, Birmingham, 30.

Effect of Cleaning on Fatigue Strength

According to J. H. FRYE and G. L. KEHL, in the "Transactions of the American Society for Metals," the fatigue strength of heat-treated steel with 0.54 per cent. C. cleaned by blasting with steel shot is greater than that descaled by hot-pickling or sand-blasting methods.

Reliability - is certainly the word to describe these bricks



You can safely rely on the firebricks supplied by the General Refractories Group of Companies giving you satisfaction in every respect. They withstand high temperatures and sudden changes of heat without melting or splitting, and their low porosity enables them to resist abrasive forces and slag action. The utmost care is taken in the production of both standard sizes and special shapes, so that they are always of the same high quality.

We supply firebricks from Scotland, Sheffield and Stourbridge, and can therefore provide you with exactly the right quality to suit your needs. Please write for further information.

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GENERAL REFRACTORIES LTD.

Telephone: *Sheffield* 31113 (6 *lines*) **GENEFAX HOUSE, SHEFFIELD, 10** *Telegrams:* *"Genefax Sheffield"*

LONDON OFFICE: Russell House, Adam St., Strand, W.C.2. Telephone: Temple Bar 3511. Telegrams: "Genefax, Rand-London." (Mr. A. C. Turner).

SCOTTISH OFFICE: 48, West Regent Street, Glasgow, C.2. Telephone: Douglas 6108 (3 lines). Telegrams: "Genefax, Glasgow." (Mr. A. McKendrick).

SWANSEA OFFICE: Metropole Chambers, Wind Street. Telephone: 3680. Telegrams: "Genefax, Swansea." (Mr. D. F. Hood-Williams).

MANCHESTER OFFICE: 9, Albert Square. Telephone: Blackfriars 6130 Telegrams: "Genefax, Manchester." (Mr. S. G. Throssell).

MIDDLESBROUGH OFFICE: Halifax Bldgs., Exchange Place, Telephone: Middlesbrough 3313. Telegrams: "Genefax, Middlesbrough." (Mr. J. A. Williams).

BIRMINGHAM OFFICE: 5, Lower Temple Street, Telephone: Midland 6376. Telegrams: "Genefax, Birmingham." (Mr. G. Griffiths).

Raw Material Markets

Holidays with pay have been granted to many employees in the iron and steel consuming industries this year, and the resultant lost time is accentuating the quietness of trade generally. An indication of the lower outputs of pig-iron in this country may be obtained from the blast-furnace statistics which accompany this issue. According to the returns, there were 21 fewer furnaces in blast on June 30, as compared with March 31. The average number in blast for the quarter totalled 104½, against 124 in the previous quarter. It would seem that further reductions in outputs will have to be made before increased business necessitates an expansion of production.

Pig-Iron

MIDDLESBROUGH.—Inquiries from home and overseas buyers remain very restricted. The decline in the export trade is a serious matter. Last year, when the demand for pig-iron was too heavy adequately to be met, makers were compelled to refuse inquiries from overseas in order to meet home requirements as far as possible, and, consequently, consumers in other countries were forced to look elsewhere for their supplies. Business lost in that way will be most difficult to regain. At the present time, makers are feeling the lack of export trade very acutely.

The hematite market shows little sign of life, and only small tonnages are changing hands. Makers have a surplus to dispose of after their own requirements have been met, but most of this excess production is going into stock.

LANCASHIRE.—Producers' difficulties in obtaining new orders are not decreasing. The weekly turnover is restricted to small tonnages for prompt delivery, and consumers are reluctant to consider buying forward. For their part, of course, it must be realised that supplies are plentiful, and will remain so for months ahead even if there is a resumption of trade, while prices are stated to be fixed until the end of the year. Thus, there is no incentive for consumers to worry about their needs. It is generally believed that quotations must be lowered after December 31. There is not much activity in hematite.

MIDLANDS.—Producers are looking forward to the autumn, when they believe that there will be a general resumption of business. Meanwhile, there is very little doing and makers are having to put much of their output into stock. On the whole, there seems to be an improvement in the call for supplies of low-phosphorus iron, but the demand is still much below normal. The price varies between £5 15s. and £7 per ton. Only a small amount of business circulates for refined iron.

SCOTLAND.—Trade in this area continues to be very quiet. In many cases, holidays are being extended, owing to the slack conditions. Prices remain at 120s. 6d. per ton for No. 1 foundry iron and 118s. 6d. for No. 3, f.o.t. furnaces. Stocks at the consuming plants are still substantial and new business is out of the question until these have been considerably reduced. Hematite mixed numbers are quoted at 133s., Scottish basic 107s. 6d., and English and Indian basic 100s., all less 5s. rebate and delivered steelworks.

Coke

Some consumers of foundry coke are of the opinion that prices will be reduced before the end of the year, which is the time fixed by producers. Consequently, there is little forward buying. In any case, consumption is now at a reduced level and many users are in possession of sufficient stocks to enable them to continue working satisfactorily. For delivery to Birmingham and Black Country stations, best Durham coke is quoted at 55s., with Welsh coke at from 55s. to 62s. 6d. per ton.

Steel

Business in the steel market has been rather quiet, and is likely to remain so until the close of the holiday season, says the official report of the London Iron and Steel Exchange. The scarcity of new business recently has been more noticeable owing to the dull trading conditions which have ruled for the past few months. There are indications, however, that some impression has been made upon the stocks which have been weighing upon the market since the first quarter of the year, and this increases the probability of a revival of the demand in the early autumn. Business in the semi-finished steel department is irregular, but is hindered by the existence of heavy stocks. Specifications, however, are reaching the works on a more liberal scale than for a long time past. New business in finished steel is quiet, but operations are well maintained at the producing works considering the time of the year, and the rather inactive markets which have ruled during the preceding few months. Some improvement is also noticeable in the position of the lighter branches of the trade. Export business, however, is poor, and overseas buyers appear to be unwilling to undertake important commitments.

Scrap

The position of the scrap market at the present time is much the same as that of the pig-iron market. Last year supplies were very difficult to procure and the British Iron and Steel Corporation organised a scheme to bring supplies on to the market. They even went to the extent of advertising in the national Press in order to induce householders to bring out their old metal. Now there is a considerable surplus of most grades. It is understood that two firms have recently disposed of 20,000 tons of scrap to Germany, though not much of this was steel scrap. Owing to the shortage of scrap last year, exports were prohibited, but it is now permissible to sell abroad when the sanction of the International Scrap Convention has been obtained.

Metals

Advices from Wall Street appear to have become rather less satisfactory, but, so far, there has been little reflection of this on the non-ferrous metal markets, which are very sensitive to conditions in New York.

Copper.—The American Bureau of Metal Statistics reports that world stocks of refined copper declined during May by 2,855 short tons. Stocks on June 30 totalled 551,495 tons, as compared with 554,350 tons on May 31. The total output of blister copper in June amounted to 143,812 tons, against 156,324 tons in the previous month. Output of refined metal last month was 142,532 tons, against 149,340 tons in May. The world apparent consumption increased in June to 145,393 tons, as compared with 136,560 tons in the previous month.

Copper production in Canada during May totalled 48,429,331 lbs., as compared with 47,750,255 lbs. in April and with 41,561,784 lbs. in May, 1937. Canadian copper production during the first five months of 1938 totalled 243,558,959 lbs., as compared with 201,055,674 lbs. during the corresponding period of last year. Copper exports in May totalled 391,779 cwts. (100 lb.), valued at $3,762,690, as compared with 264,717 cwts. ($2,570,368) in April, and with 232,203 cwts. ($3,406,374) in May, 1937. Exports to the United Kingdom in May totalled 265,813 cwts. ($2,552,389).

Although new business continues to be rather dull, the undertone of this market is quite strong. On the Continent, buying has been satisfactory and on quite a large scale at times.

Metal Exchange quotations were as follow:—

Cash.—Thursday, £38 10s. to £38 12s. 6d.; Friday, £38 18s. 9d. to £39 1s. 3d.; Monday, £39 13s. 9d. to £39 16s. 3d.; Tuesday, £39 18s. 9d. to £40; Wednesday, £40 3s. 9d. to £40 5s.

Three Months.—Thursday, £38 16s. 3d. to £38 17s. 6d.; Friday, £39 5s. to £39 6s. 3d.; Monday, £40 to £40 2s. 6d.; Tuesday, £40 5s. to £40 6s. 3d.; Wednesday, £40 10s. to £40 11s. 3d.

Tin.—In this metal, also, consumers have given little support, yet the tone, generally, is firm. The weekly market report issued by Rudolf Wolff & Company states that "business with consumers in this country continues dull and Continental demand remains quiet. America has bought spasmodically, but conditions there have been to some degree influenced by the hesitant tone of the American stock market and the uncertainties which prevail in the steel industry. While the outlook is regarded with moderate optimism, there is still so much uncertainty with regard to trade and industrial development in the future that, in spite of the strong control exercised over output, buyers are content to adopt a cautious attitude. On the other hand, there is no evidence of weakness, for the statistical position is expected to improve in the next few months and the situation, therefore, does not encourage bear selling. As in other markets, the position in America and economic developments in that country are still an important influence.

The Straits Settlements Government has now issued the domestic arrangements for the financing of the tin buffer pool. Malayan tin producers will receive from the Government a maximum advance of about £98 per ton of metal contributed to the pool. Duty, freight and smelting costs will be deducted from this sum, while interest of 4½ per cent. will be charged. Contributors not requiring the advance will have to pay tin duty calculated on the Singapore price ruling at the time, as well as export and other charges. The Government has decided to buy outright through the Straits Trading Company or the Eastern Smelting Company any contribution to the pool of less than 25 piculs (about one and a-half tons) delivered by a licensed dealer.

Official quotations were as follow:—

Cash.—Thursday, £190 5s. to £190 10s.; Friday, £191 to £191 5s.; Monday, £192 5s. to £192 10s.; Tuesday, £193 to £193 5s.; Wednesday, £194 5s. to £194 15s.

Three Months.—Thursday, £191 10s. to £191 15s.; Friday, £192 5s. to £192 10s.; Monday, £193 10s. to £193 15s.; Tuesday, £194 to £194 5s.; Wednesday, £195 10s. to £195 15s.

Spelter.—Although no official *communiqué* has yet been issued, it is learned on reliable authority that efforts at a resuscitation of the International Zinc Cartel are being carried out. It is anticipated that if any decision between the producers is reached, the new Cartel will be on very different lines from the previous body, which expired at the end of 1934. It would certainly appear that the present negotiations are further ahead than most of the attempts that have been made since the last Cartel went out of operation, but these discussions have so often ended in disappointment. The market has been steady during the past week, with no particular feature.

Daily market prices:—

Ordinary.—Thursday, £13 18s. 9d.; Friday, £13 18s. 9d.; Monday, £14 2s. 6d.; Tuesday, £14 2s. 6d.; Wednesday, £14 3s. 9d.

Lead.—The trend of this metal is still somewhat unsettled, but quite a firm tone continues. New business remains quiet, and there is unlikely to be much change in this respect for some time to come, as this is usually the quietest period of the year. The Ministry of Labour returns for the building trade show that the total plans passed in June amounted to £8,530,300, as compared with £9,204,600 in May. Despite the decline last month, the figures for the two months of May and June are considered to be satisfactory.

Day-to-day quotations:—

Soft Foreign (Prompt).—Thursday, £14 11s. 3d.; Friday, £14 13s. 9d.; Monday, £14 12s. 6d.; Tuesday, £14 13s. 9d.; Wednesday, £14 13s. 9d.

Scrap.—In the early part of the week many consumers took up quite substantial parcels, but the activity in buying has since slackened off to some extent, although the market, generally, remains brighter than for some time past. There is little change in prices over the week.

Approximate selling prices for old metal:—New aluminium cuttings, £72; rolled, £56; cast, £28; foil, £88. Copper, £36 to £39; braziery, £32. Brass (clean), £22 to £25. Zinc, £9. Lead, £14. Gunmetal, £40.

International Scrap Convention

A meeting of the London committee of the International Scrap Convention was held recently. After a thorough review of the position, it was decided not to make any further purchases, the requirements of all groups being fully covered for some considerable period ahead.

"Sif-Tips" Welding Magazine

The 25th issue of "Sif-Tips" begins a new series of this well-known quarterly house-magazine on welding. The journal has been reduced and is now of the "pocket" size. Copies can be obtained free of all charge from the Suffolk Iron Foundry, Sif-bronze Works, Stowmarket.